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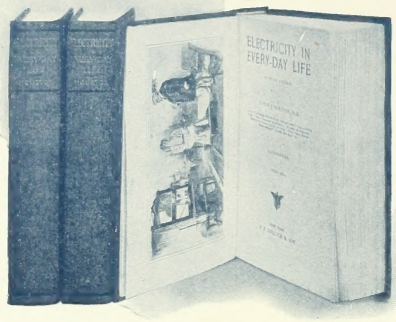

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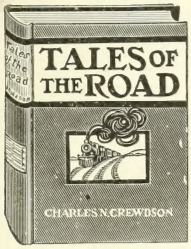

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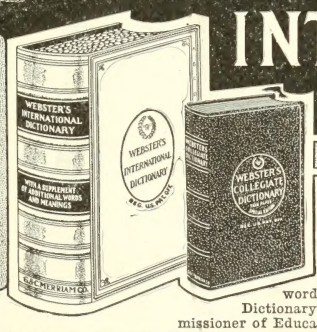

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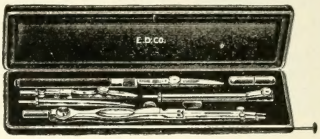

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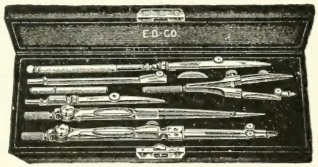

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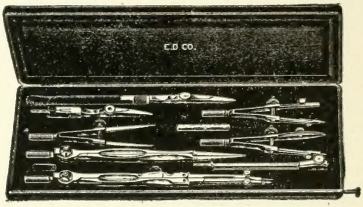

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UP STAIRS

"We aren't printing enough technical articles," declared the Engineering Editor, savagely brandishing a bundle of letters. "All these subscribers are kicking!"

"We're filling the magazine up with dry scientific and technical stuff," the Human Interest Editor countered with equal earnestness. "See here!" He waved some letters of his own.

For an instant it looked as if there might be trouble. Editing a growing and successful magazine is strenuous business. Then the Editorial Doctor of Philosophy, who hates a row, put in his oar.

"I think we can please both of you gentlemen," he said mildly.

"How?" they roared at him, in chorus.

"It's our field to tell how things are done, is'nt it? To satisfy the eternal how-wonder of mankind?"

"Well, what if it is?" they both demanded.

"All such subjects are technical subjects, you'll admit."

The Human Interest Editor started to object, but the Doctor of Philosophy paid no attention.

"Now don't get frightened by a word," he said.

"You can't tell how anything is done without being, technically, technical, but that don't mean you can't be simple and dramatic and interesting and easily understood at the same time. Our subjects will be technical, if you insist on it, our information will be accurate and exact, but we'll tell our stories in such a way that even *you* can understand them."

He nodded towards the Human Interest Editor, who didn't look flattered at the implication.

"But that sort of thing lacks thrill, color, life, picturesqueness," the latter put in by way of covering his confusion.

"Don't be stubborn," urged the Ph. D., who was getting a bit heated himself. "Take that story we're going to print in the January number about how the glaciers on the top of Mt. Rainier are running mills and factories forty miles away in Tacoma. You can't read it without a thrill. You can't look at

With THE EDITORS

the photographs without being moved by the grandeur of the scenery. You can't get a mental picture of the process by which melting snow on the top of a remote mountain is transformed into power at the end of a forty mile wire without feeling a glow of admiration at the marvelous things men are doing in the world."

"Wonderful enough, yes. It's the touch of human interest which is lacking."

"I defy you to read this story about 'Our Industrial Martyrs' without tears coming into your eyes. Is that what you mean by human interest?"

"Yes, in a way. But what have you got that'll stir the blood a bit; something to make a fellow sit up and take notice?"

"You're young, say, and like adventure; take this other January story—'Hunting the Great Right Whale'—with its remarkable photographs. That ought to send the shivers up any man's backbone. Or read what the youngest Commissioner of Public Works in the world is doing in the second greatest city of the United States, and see if you don't get a thrill of another kind."

"Something solid, you want, instructive at the same time it is interesting? Well—you eat bread every day. I suppose you think you know how flour is made out of wheat. Here's a story on the Great Modern Flour Mills that will teach you how little you do know about the subject."

"In fact" said the Editorial Ph. D., whacking his desk in emphasis, "it's going to be a really remarkable number—not a word about graft in it, for one thing. I'm not sure," he went on with a twinkle in his eye, "that we ought to send out such a cracking good magazine for ten cents."

"Why not?" asked the other Editors smilingly.

"In the first place it's going to be hard to keep up the lick. And once the people got a glimpse of what they can buy for a dime I'm really afraid they'll be mobbing the news-stands."

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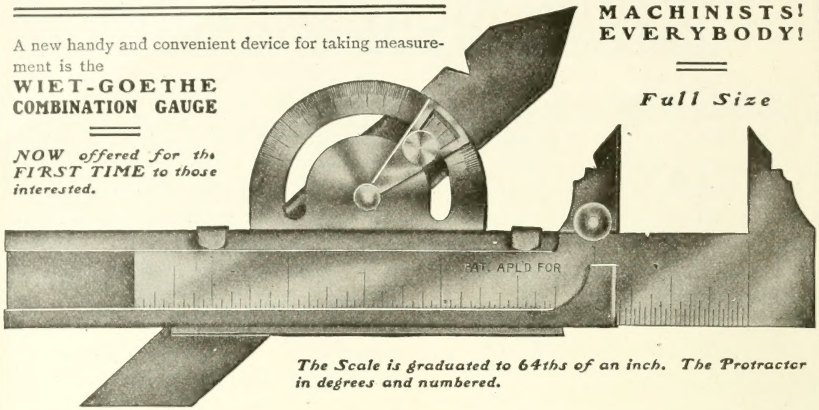

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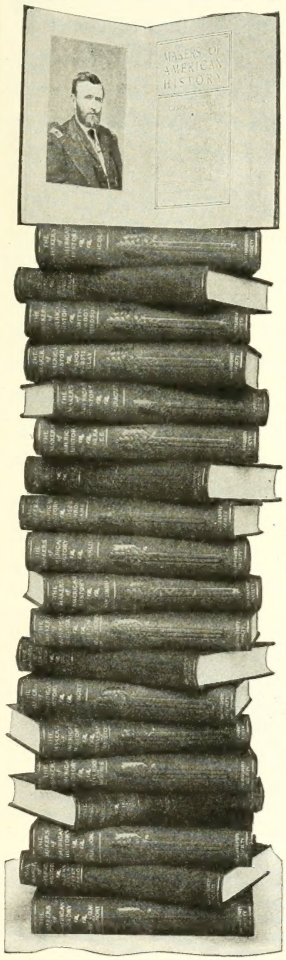

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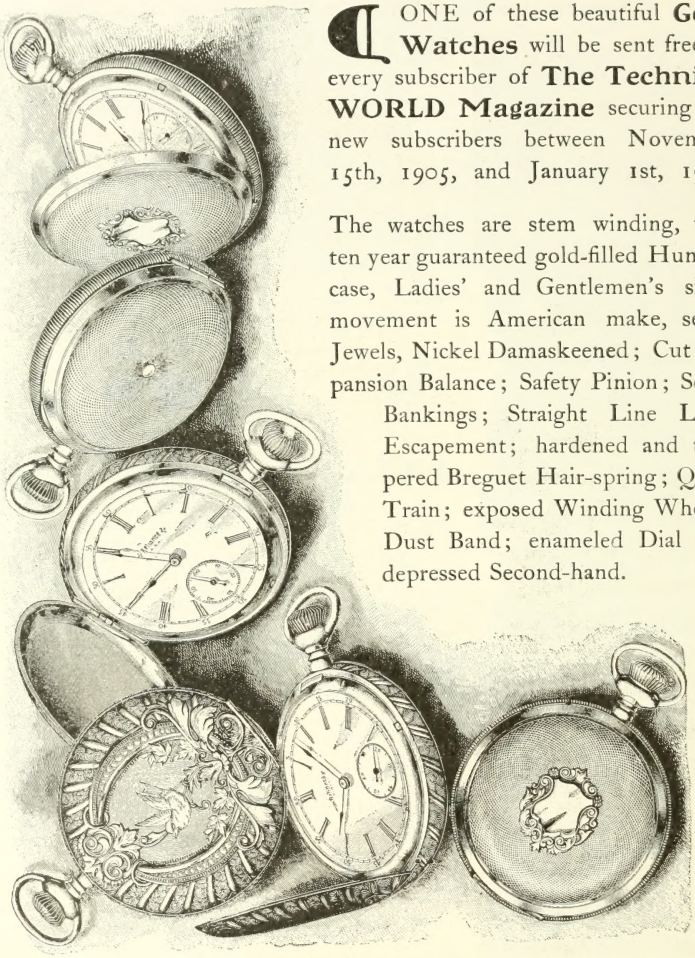

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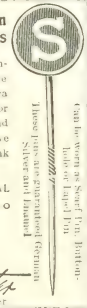

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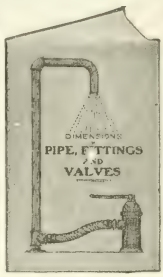

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Ainslee's Magazine

CHRISTMAS NUMBER

¶ The Christmas number of *Ainslee's Magazine* will touch the culminating point of twelve months of extraordinary development. Its table of contents will include the best work of some of the most notable figures in American current fiction, whose stories are eagerly and persistently sought for by publishers everywhere.

Edith Wharton

author of "The House of Mirth." Her story, one of her best, will be *"The Introducers."*

Lloyd Osbourne

the author of books that are almost classics, will contribute a Christmas story in a novel setting, entitled *"Mr. Bob."*

O. Henry

the unrivalled teller of short stories and author of "Cabbages and Kings," will have one of the most remarkable short stories he has ever written, *"Blind Man's Holiday."*

Marie Van Vorst

will conclude, in this number, *"The Warreners,"* a serial that has made a sensation.

Mrs. C. N. Williamson

who, with her husband, has had almost more than her share of success with "The Lightning Conductor" and "My Friend the Chauffeur," will have, in *"The Man in the Moon,"* a delightful Christmas story.

Julien Gordon

will have an essay on *"Fairy Godfathers,"* and **Anne Rittenhouse** one on *"Society's Christmas Sacrifice."*

Allan Dale's

dramatic article will be spicier than ever, and the department *For Book Lovers* will have some unusually interesting news for novel readers.

There will be stories by **Owen Oliver, Edith Macvane** and **Felicia Goddard. Mrs. Wilson Woodrow** will continue her bright *"Conversations with Egeria."*

COVER DESIGN BY HARRISON FISHER

¶ Plans are matured for 1906 which will retain for *Ainslee's Magazine* the literary premiership which rightfully belongs to it. Much thought and much money have been expended in the development of these plans, and this Christmas number will give our readers some idea of what to expect for the next twelve months.

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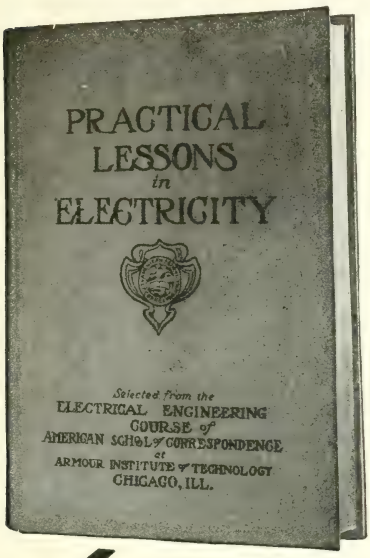

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ELECTRIC WIRING, by H. C. Cushing, Jr., (author of "Standard Wiring"); Dynamo Installation; The Switch Board; Lightning Arresters; Motor Installation; Tables, Transformers, Three-Wire System; Poles and Pole Setting; Inside Wiring, Arc Light Wiring; Conduit Work; Fixture Wiring; Cut-outs; Switches; Distribution of Light; Arc and Incandescent Systems; Fuses; Inspection, etc.

ELECTRIC BELL WIRING, by H. C. Trow, S. B.; Methods of Wiring, Joints, Batteries, Dry Batteries, Bells, Circuits, Annunciators, Burglar Alarms, Fire Alarms, etc.

ELECTRIC CURRENT, by L. K. Sager, S. B.; Volt; Ampere; Ohm; Resistance; Conductivity; Tables; Circuits; Grouping of Cells; Quantity; Energy; Power; Coulomb; Joule; Watt, etc.

ELEMENTS OF ELECTRICITY, by L. K. Sager, S. B.; Magnets; Experiments with Magnets; Magnetizing Steel; Conductors and Insulation; Electric Machine; Leyden Jar; Voltaic Cell: Types of Cells; Electromagnets; Induction Coil; Electrolysis; Electrotyping and Electroplating; The Telephone, The Telegraph, Sounder, Alphabet; Key; Battery, Relay, etc.

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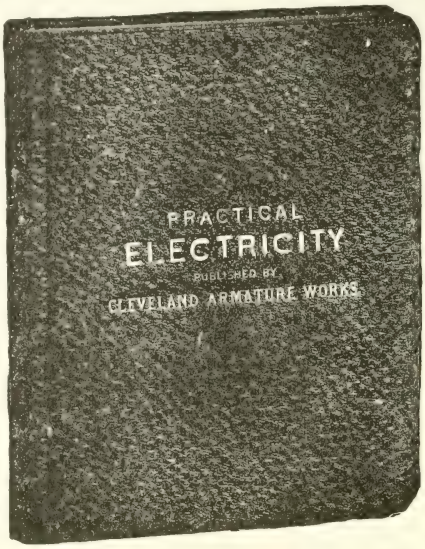

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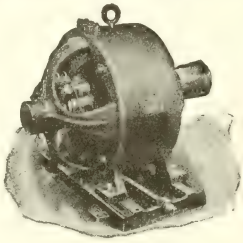

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G. P. BLACKISTON.
Iron and Steel Expert, Author, and Inventor.

Born in Cumberland, Md. Educated in Washington, D. C. Made practical study of iron and steel industry, filling positions of melter, roller, hammerman, and others in Pittsburg mills. As inventor, has patented car fenders, car couplers, and other devices, and is now working on a special furnace for steel melting, which does away with the pots in the crucible process. As an author, he has contributed to many of the leading scientific and literary magazines in the United States and abroad. We call attention to his article, "Story of the Iron Industry," in this number of THE TECHNICAL WORLD MAGAZINE.

WATCHING THE HATED FOREIGNERS, ACROSS SHAMIEN CANAL, CANTON, CHINA.

(*See page 442*)

The Technical
World Magazine

Volume IV DECEMBER, 1905 No. 4

Story of the Iron Industry

How Lake Superior Ore is Turned into Most Valuable of Pigs

By G. P. BLACKISTON

Iron and Steel Expert

In the last twenty-five years the production of iron in the United States has increased eighteen-fold. This industry and those growing out of it have made more men millionaires than any other single line of business. The following article describes accurately and simply the processes which follow the digging of iron ore from the great Lake Superior mines—richer, they are, than any diamond or gold mines—until it is turned into the pig iron of commerce. Mr. Blackiston, the author, is one of the leading authorities on the subject. See back of frontispiece.—*The Editors.*

OUT of the world's annual production of forty to fifty million tons of pig iron, the United States alone furnishes about eighteen million tons, or two-fifths of the entire output. This, if loaded into ordinary freight cars, would make a train extending over ten thousand miles, or two-fifths around the globe. If made into telegraph wire three-sixteenths of an inch thick, it would extend from the earth to the sun, a distance of almost one hundred million miles. Although the great bulk of this vast production is consumed in the United States, three to four hundred thousand tons are annually exported.

Over forty million dollars are annually paid in wages to the eighty thousand men and boys employed in the production of pig or cast iron. The yearly valuation of this product is over two hundred and fifty million dollars.

The ever-increasing consumptive power of the United States for iron and steel products has caused a phenomenal growth in this branch during the last twenty-five years. During this period it has risen from a little over one million to eighteen million tons. Of this tonnage Pennsylvania contributes about forty-seven per cent, while Ohio produces seventeen per cent, and Illinois about ten per cent. The growth of iron manufacture in these three states has been one of the most notable features of the industrial growth of the United States. The production of Pennsylvania alone to-day is seven times greater than the entire production of this country in 1870.

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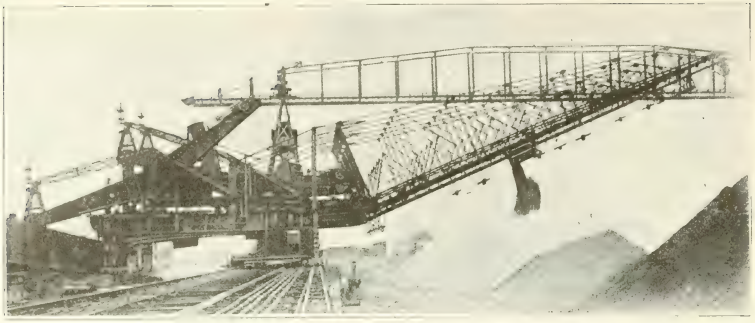


THE UNLOADERS AND STOCK PILE OF A MODERN DOCK.

United States in Lead

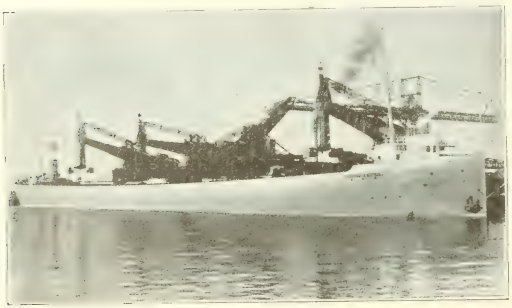
In 1870, when railroad construction was most active in this country, England, which produced three times as much iron as did this country, furnished us with all of our rails and other material. After that, Germany took the lead, but only to be surpassed by the United States, which to-day has an output almost equal to that of England, Germany, and France combined.

The great and rapid advancement of the United States in this branch of industry is due, to a great extent, to its rich, reliable, and easily obtained iron ore and its unsurpassed coking coal, the two forming the most essential ingredients used in iron making. These, aided by the modern and inexpensive handling and by splendid transportation facilities, reduce the cost of manufacture to such a low figure that American iron can be transported and sold in foreign countries at a large profit.

The channels of consumption of this enormous tonnage are numerous and extensive, affecting almost every walk of life. Five million tons is of grades suitable for foundries, for the production of iron castings for machinery, railroad rolling stock, cast-iron pipes, and a variety of small uses. About half a million tons is converted into wrought iron, while another half million is used for steel castings. The remainder, amounting to about eleven million tons, is utilized as the basis of steel manufacture.

Iron a Prehistoric Product

The actual manufacture of iron dates back almost to the prehistoric era, but it was not until 1620 that it was introduced into the United States. From that time on the improvements were rapid and wonderful, the foremost of which were the introduction of coke in the eighteenth century, the steam engine in 1769, and the hot blast of J. B. Neilson in 1828.

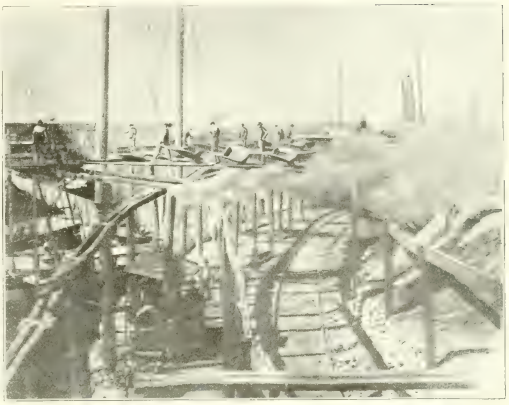


UNLOADING A VESSEL.
The modern method of unloading the huge ore-carriers at the rate of six to seven thousand tons every ten hours.

A splendid example of one of these antiquated furnaces can still be seen near Lakeville, Conn. It was built in 1762; and so excellent was its product that cannon, cannon balls, shells, etc., were used therefrom, as also the large chains which were stretched

across the mouth of the Hudson during that exciting period.

Pig or cast iron is not pure iron, but an alloy of which iron is the most important ingredient. Unlike many of the common alloys, such as bell metal or brass, which are composed of a mechanical mixture, it consists of a large, complex union of many and different elements, such as carbon, manganese, silicon, sulphur, phosphorus, etc. The most important of these is carbon, which gives fluidity to the metal when molten and hardness when cold.



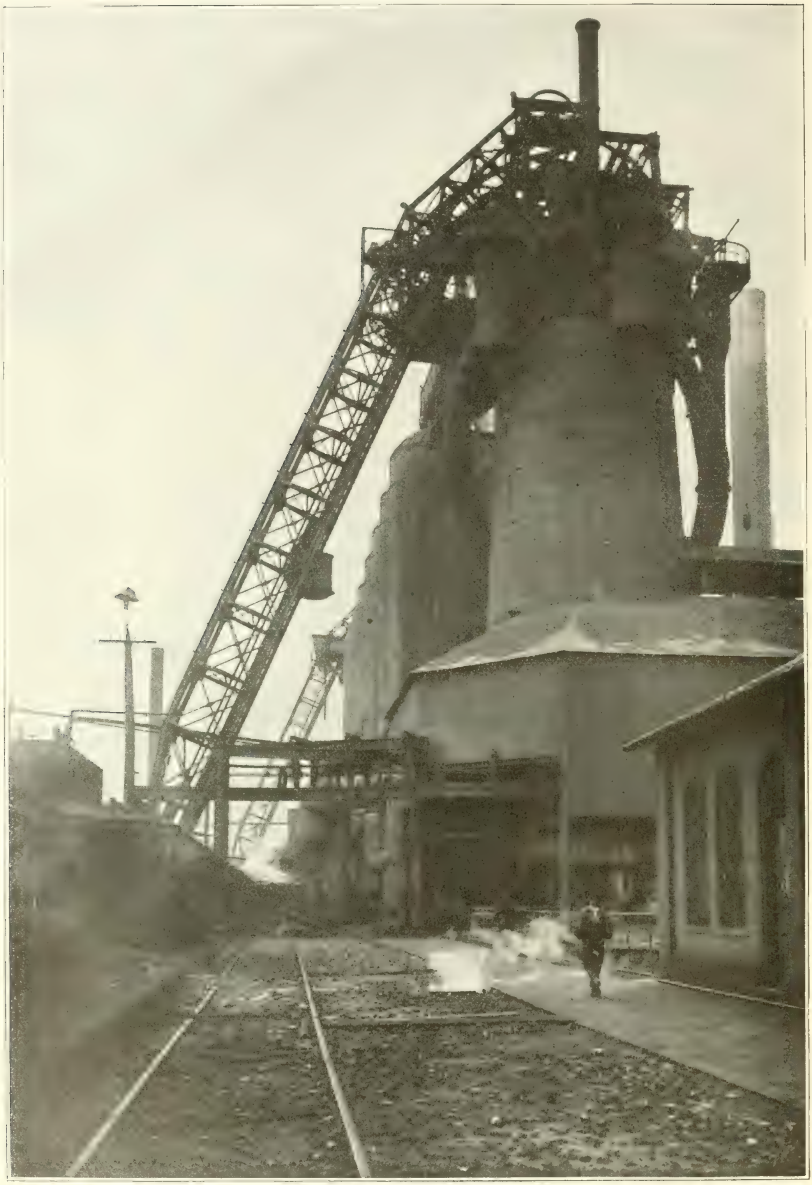
OLD METHOD OF UNLOADING ORE VESSELS.

The three principal ingredients used in its manufacture are iron ore, coke, and limestone. In a few cases, charcoal, anthracite, and bituminous coal are used, alone or mixed, in place of the coke. All of these are plentiful in this country and of most excellent quality.

The iron ores of this country are divided into four general classes, the high-grade ores containing about fifty to sixty per cent of iron, and the low ores, thirty to fifty.

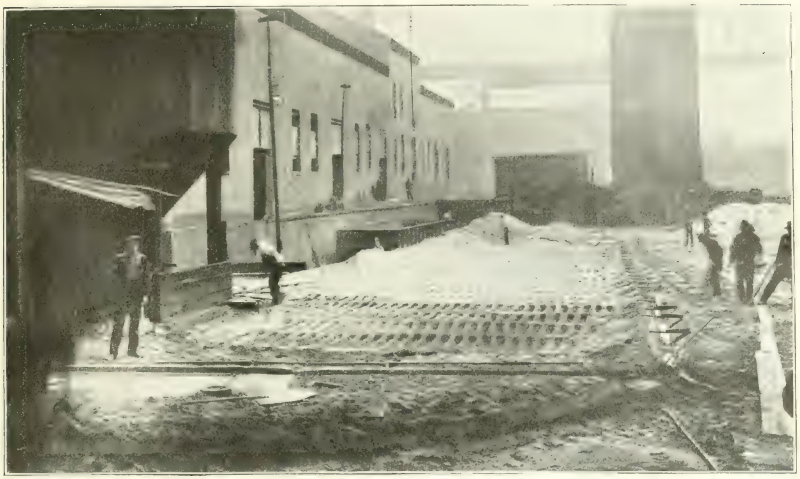
Although small quantities of ore are found in Alabama, New York, Pennsylvania, New Jersey, Wisconsin, Minnesota, Michigan, Virginia, and West Virginia, about eighty per cent of the total is mined in the famous Lake Superior region, of which the following are the principal ranges: The Masaba in Minn-

A STEAM SHOVEL "BUCKING" A BANK OF ORE.



MODERN BLAST FURNACE, THE RECORD-BREAKER OF THE WORLD.

The photo shows the skipway, up which the material is carried to the top of the furnace. The downcomers, or pipes down which the gas travels, are also very plainly illustrated.



A STREAM OF MOLTEN IRON RUNNING INTO THE SAND MOULDS, FORMING THE ROUGH BARS, WHICH, WHEN SOLIDIFIED, ARE TERMED "PIGS."

esota, the Menominee in Michigan and Wisconsin, the Marquette in Northern Michigan, the Gogebic in Michigan and Wisconsin, and the Vermillion in Minnesota.

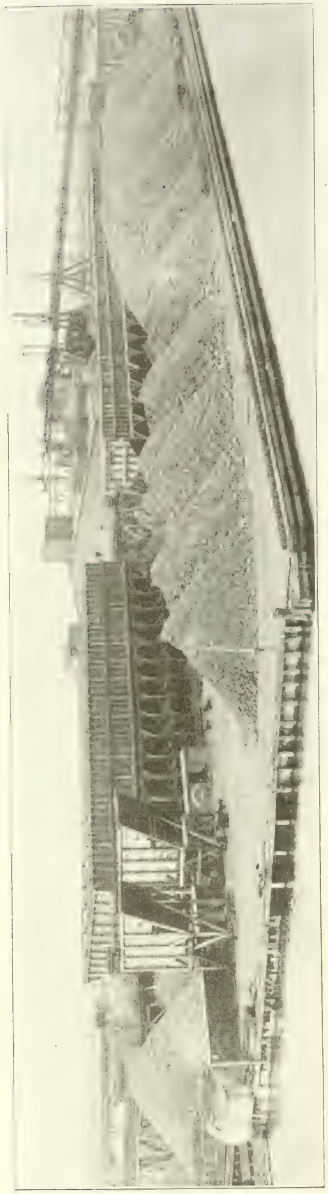
The iron ore in the United States may be considered in four general commercial classes—red and brown hematite, magnetite, and carbonate. Of these four, the red hematite is the most popular, because of its richness in iron and its freedom from foreign and non-metallic material. These classes are subdivided under various local or trade names.

Three general methods are employed in the United States in mining the ore—surface, drift, and underground. In locations where the ore is very hard or lies at a depth of sixty feet or more from the surface, the latter method is employed. Shafts or tunnels are driven to the ore beds, which are then worked in a similar manner to coal. In those districts where the ore is found in a loose condition just under the surface, surface mining is almost altogether followed.

Surface Mining for Iron Ore

Where surface mining is employed, the ore must be easy to get at. The top soil is first removed by steam shovels, after which the ore can readily be taken out in the same manner. The mine being thus opened or "stripped," tracks are laid in all directions upon the face of the deposit. These excavations are usually worked in terraces. The ore, being lifted

AN OLD-TIME BLAST FURNACE.
One of the first furnaces in this country, still standing near Lakeville, Conn.



A MODERN ORE DOCK.

by the numerous steam shovels, is placed directly on specially constructed cars, in which it is hauled to the docks. In this manner immense quantities of ore are obtained at a cost not exceeding forty cents a ton, while the drift and underground require an expenditure of seventy to eighty cents a ton.

The ore ranges of Lake Superior have added more to the economical advancement of American iron than any other single thing. They have given birth to the thousands of miles of railroads that are scattered throughout that district and that devote their entire traffic to the transportation of iron ore. They have added to the Great Lake shipments millions and millions of tons; given employment to thousands of boat builders and crews; forced the Government to make improvements throughout their course; and caused the growth of towns all through the mining districts and the building of the largest docks in all the world.

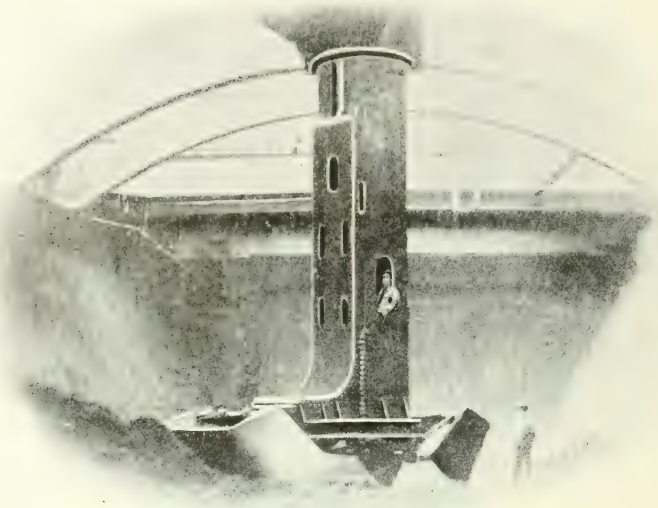
Mammoth Labor-Saving Docks

With more than typical American enterprise these docks are built with the latest labor-saving devices. The specially constructed cars are run out upon them, and their hopper floors dropped, permitting the ore to fall into numerous bins below. Underneath and on both sides are long rows of chutes through which the ore passes into the holds of the large ore-carriers. These boats are invariably filled to their very hatches. Over twenty-one million tons of ore were transferred through these docks last year. The magnitude of these structures that extend like an immense peninsula into Lake Superior, can therefore readily be imagined.

A large fleet of steamers are constantly plying between their Western docks and the Eastern unloading harbors all during the summer and fall months when the northern Lakes are open for navigation. In winter all shipments are suspended; consequently a large accumulation of ore must always be stored in the East, either at the docks or at the furnaces. Some vessels have a tonnage of six thousand tons, and so perfect are the loading facilities that it seldom requires over five hours to load them.

After a trip through Lakes Superior,

MOUNTAINS OF IRON ORE IN STOCK AT THE FURNACES, WAITING TO BE CONVERTED INTO PIG IRON.



ARM AND BUCKET OF ONE OF THE LARGE UNLOADERS IN THE HOLD OF A VESSEL.

Michigan, Huron, and Erie, the immense ore vessels, whether large, ordinary steamers or still larger and strange whalebacks, arrive at one of the many unloading docks of Cleveland, Conneaut, or Ashtabula.

Here, more than anywhere in the world, have the ingenuity and skill of the American engineer been demonstrated, for on every side are the huge yet rapid machines that transfer the ore from the dark depths of the ship's hold to the huge pile on the docks. These monsters of steam or electricity have grown to such perfection and magnitude that the ore boats are rarely held longer than ten hours to have their contents transferred to the storage piles. The boats usually return west with coal as ballast.

THE CASTING MACHINE.
The modern method of solidifying the iron.

As wanted, the ore is loaded into cars, either directly from the steamers or from the stock piles, and transferred by rail to the furnaces. The great Pittsburg district is the destination of the greater portion of this ore. So thoroughly mechanical and free from labor have been these numerous operations of mining, loading, transporting, and delivering the ore in the Pittsburg district, that an expenditure of only two dollars and fifty cents a ton has been incurred.

The greatest advancement which American iron manufacture has made in recent years is in the handling of the raw and finished materials at the furnaces. This is due largely to the great increase of tonnage during the past ten

years. Over ninety million tons of raw and seventeen million tons of finished material were handled last year at the four hundred and twenty-eight furnaces scattered throughout the United States. The raw material alone represents an expenditure of over one hundred and thirty million dollars.

Mighty and Almost Human Machines

In contrast with the old-fashioned method of hand labor, the mighty and all but human machines are to-day employed. From the moment the long trains of ore, coke, and limestone arrive, through the period of unloading, charging, melting, casting, and loading the finished iron, man never once enters into the operation. The ore cars are lifted upside down and their contents dumped into large iron buckets, which automatically carry them either to the long row of bins or to the large stock piles. The cars containing the coke and limestone are run upon a trestle under which are arranged the bins. By this method they can deliver their contents directly into the bins without any additional handling, the cars being provided with bottom gates. Many of the largest plants have sufficient bin space to permit a large quantity of ore to be similarly stocked, thus reducing the cost and holding the large stock supply for emergency and winter usage.

The modern blast furnace is a gigantic structure, oval in shape and towering some ninety to one hundred feet in height. It consists of an outer coating of steel plates, with an inner lining of fire brick. Accompanying these stacks are invariably two or more cylindrical steel structures known as stoves. They are usually smaller in diameter but as high as the stacks themselves. Their particular work consists in utilizing the waste gases to heat the blast for the furnace.

RUNNING THE MOLTEN IRON INTO LADLES.

How Furnaces Are Charged

Running parallel to the long row of furnaces are the immense steel bins or trestles filled with the ore, coke, and limestone. At the bottom of this structure are small electric cars which are kept busy transferring the desired ingredients—ore, coke, and limestone—from the pockets at the bottom of the bins to the skip car. This being done, the skip, which operates upon an inclined track from the ground to the top of the furnace, is conveyed to the top, where it automatically empties its charge into the upper or receiving bell. When filled, the bottom of this bell is lowered and the material allowed to fall into a second and larger receiver. When this has received its full quota, consisting of several such loads and known as a "charge," its bottom is lowered and the charge distributed uniformly in the furnace over the top of the previous charge. By these two bells or bottoms, the top of the furnace is at all times closed. The furnace is usually kept filled within a few feet of its top.

But this is only a portion of the operation—the food, as it were—the huge digestive organs in the interior being continually at work. Encircling the lower outside portion of this tremendous test tube, so to speak, is a large pipe punctured at regular intervals by smaller ones which terminate in the interior of the furnace. As the powerful air-blast goes rushing through these nostrils into the body of this massive creature, where every atom of it is caught and utilized in some form or shape for the complicated reaction therein, it sounds like the heavy, powerful breathing of some maddened beast.

CLOSING THE IRON NOTCH AFTER RUNNING A BLAST FROM THE FURNACE.
The large pipe circling the furnace is the bustle pipe, through which the hot blast is carried to the furnace.

What Happens in a Blast Furnace

There are two distinctive series of operations in the blast furnace—those which accompany the charged materials on their downward journey, and those of the ascending gases.

As before stated, the superheated air-blast enters the lower portion of the furnace from all sides at a pressure of about sixteen pounds to the square inch. Immediately upon its contact, the coke or coal, whichever is used as fuel, becomes combustible, the oxygen of the blast uniting with the carbon of the fuel, forming

the gas CO_2 and a most intense heat. This gas ascends, and during its contact with the charge is reduced to CO. Upon its contact with the highly heated ore and limestone, the CO reduces the ore, the other gases assisting by heating the materials in the upper portion of the furnace. The limestone is first changed into caustic lime, which unites with the alumina and silica of the ore and ash of the fuel, with the result of a double silicate of lime and alumina. This is very fusible and does not mix with the iron.

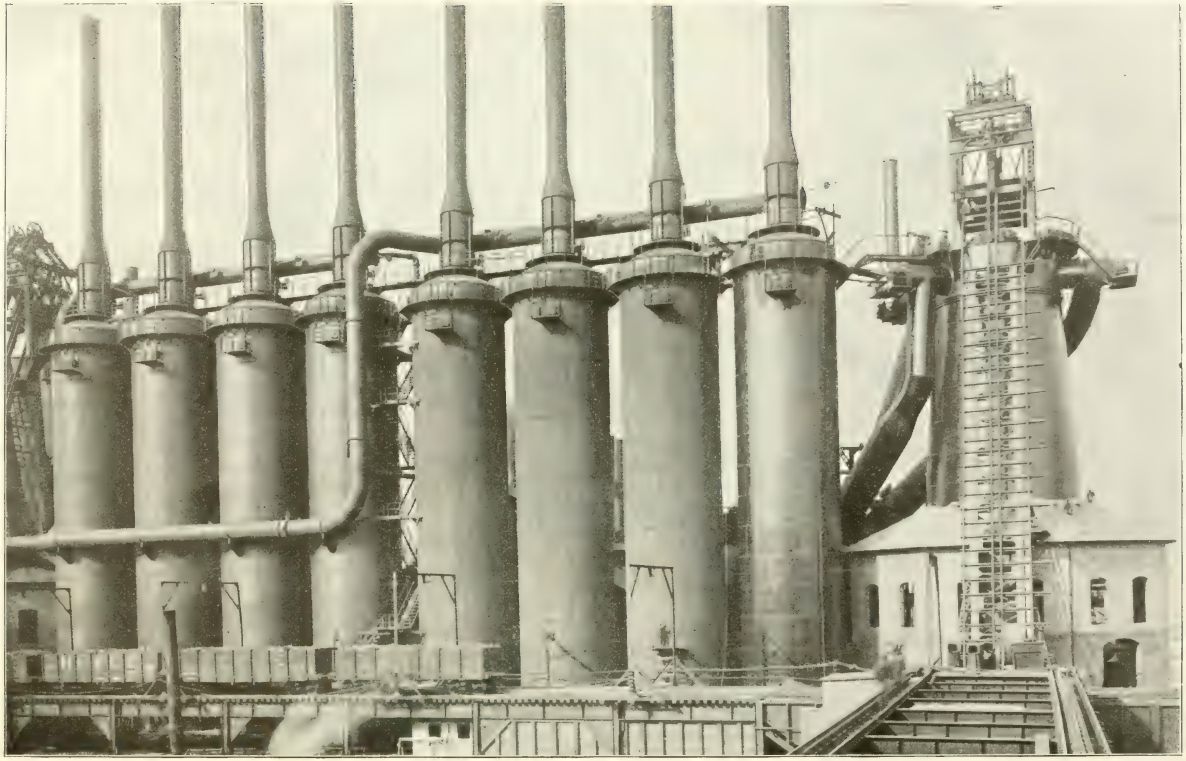
The incombustible and solid matters are so mixed and proportioned with the combustible and fusible materials that the entire charge, when heated, will result in only fusible matter.

The slags, caused from the earthy matters of the ore mixing with the fluxes, follow the iron on its downward course. This, in turn, drips or falls into a large brick-lined receptacle in the bottom of the furnace. Owing to their lower specific gravity, the slags float on top of the iron, protecting the same from the influence of the blast.

RUNNING THE HOT SLAG FROM THE FURNACE INTO THE CINDER OR GRANULATING PIT.

What Becomes of the Gas?

The gases accumulating from this conglomerate mass of liquid, semi-liquid, and heated substance, rise to the top. Not



A MODERN BLAST FURNACE WITH ITS ARMY OF STOVES.

finding an escape through the charging bells, they dart down the two or more "downcomers" which are provided for this purpose. Here they are led through a box, where the cinders and other solid matters are extracted. A portion of the gases is now carried through pipes to feed the boilers, while another portion is utilized in the heating of the stoves.

These stoves, as before mentioned, are large, cylindrical structures whose interiors are masses of fire brick. These bricks are so arranged as to allow the greatest amount of surface to be exposed. In this manner they are thoroughly heated. Each furnace has a set of such stoves, some of which are always being heated, while others are giving their heat to the blast which is driven through them prior to entering the blast furnace proper. At intervals these stoves are changed, the cold ones heated and the hot ones employed for heating. This method of utilizing the waste gases is a comparatively new invention, but one which has almost revolutionized the iron industry.

How Hot Iron is Cast

Formerly there was but one method of casting pig iron; but, because of the rapid advance in the uses to which this material is adapted, several methods are now employed. The ultimate results of these methods are of a physical rather than a chemical nature. In any case, however, the iron is first tapped through an opening near the bottom of the furnace, at periods of four hours' duration. Leading from this opening is a long channel in the sand, through which flows the white, glittering iron.

If it is to be cast in the form of sand pig, the metal runs into a long channel in the sand, with smaller ones running at right angles to both sides. These are called "sows." Flowing from the sows, the iron is fed into smaller moulds, about three feet long and four inches wide. When solidified, these "pigs," as they are termed, are broken from the sows and loaded into cars, ready for shipment. Iron thus cast has an accumulation of adhesive sand upon its surface. It is not extensively used in any processes where sand or silica is a detriment.

Cup Moulds Sometimes Used

When wanted for basic purposes and free from sand, another method is employed. Instead of permitting the iron to run into the sand moulds, it is run through the channels into specially constructed ladles or vessels which operate upon wheels. These have a capacity of 18,000 pounds each; five to six are usually filled from each blast or cast. As filled, they are drawn to the casting house, where they are tilted in such manner as to permit the molten metal to run into an

FILLING THE SKIP CAR WITH THE NECESSARY MATERIAL TO MAKE A CHARGE

endless chain of cups. These cups are about two feet long and eight inches wide at the base, and are attached to an endless chain that rests upon a track. By means of an engine or motor, the chain is revolved, the cups passing through a long tank of water, at the end of which is an incline, up which the chain bearing the cups passes. When it reaches an elevation of about ten feet, the chain passes over two gear wheels on its way back. The cups turn up-side-down, throwing their now solid contents into a car beneath.

During recent years the expense of casting has been greatly lessened by the invention or practice of using the iron direct in its molten condition. It is transferred in ladles direct from the blast furnace to the steel furnaces, thus avoiding a second melting in the latter operation.

What Happens to the Slag

The slag is run off at irregular intervals, in a manner similar to the iron, but through an opening above the iron line. This avoids any possible waste of iron. Channels are built in the sand to lead the slag from the furnaces to either a granulating pit or to the ladles. In the former case it falls into a large pit or well containing water. The hot, liquid slag, coming in contact with the water, solidifies in the form of shot or sand. This is continually being lifted out by large electric scoops and loaded into cars. In this form it is utilized either for cement or ballast. If ladles are used, the molten slag is allowed to flow into several specially built ladies, which, when filled, are carried away and dumped into ravines and hollows.

There are many grades of iron, different only as to their chemical composition. The most common of these are: Foundry, gray forge, mottled, white, standard Bessemer, basic, and malleable Bessemer. The foundry irons are subdivided into Nos. 1, 2, and 3, according to the percentage of silicon.

Analysis of Pig Irons

The following table gives a rough analysis of the several grades of pig iron:

GRADE	SILICON	SULPHUR	PHOSPHORUS	MANGANESE
No. 1 Foundry.....	2.50% to 3.00%	.03% and under	.40% to .80%	.30% to .60%
No. 2 Foundry.....	2.00% to 2.50%	.04% and under	.40% to .80%	.30% to .60%
No. 3 Foundry.....	1.75% to 2.25%	.05% and under	.40% to .80%	.30% to .60%
Gray Forge.....	1.25% to 1.75%	.07% and under	.40% to .90%	variable
Mottled	about 1.00%	.10% and under	variable	variable
White.....	about 1.00%	.15% and under	variable	.....
Standard Bessemer...	1.00% to 2.00%	.05% and under	.10% to .20%	.....
Basic.....	1.00% and under	.05% and under	.50% to 1.00%	.....
Malleable Bessemer..	1.25% and under	.05% and under	.15% and under	.....

Anti-Auto Riots of 1830

When Pioneer Automobilists were Stoned and Mobbed, and their Motors Driven from the Roads

By MALCOLM McDOWELL

Author of "Shop Talks," Editorial Staff TECHNICAL WORLD MAGAZINE

AUTOMOBILISTS, who have been fined for fast running, stoned by irate farmers, pestered by officious constables, and lampooned by newspapers, may take comfort in the knowledge that their originals, some seventy-five years ago, passed through the same experiences—only more of them. The first quarter of the last century developed an automobile craze fully as virulent as the fad of to-day. In the 1820's and 1830's, steam wagons to run on common roads, turnpikes, and toll roads, became so popular with the higher classes in England that the directors of stage coach companies and breeders of horses took alarm. They used their influence to slip a number of little bills through parliament, permitting toll roads to levy tolls designed to be prohibitive on steam carriages and wagons. The steamers were compelled to pay five and ten times as much toll as was charged the largest six-horse stage coach.

Horses Drop Dead From Fright

The stage coach companies all over England and Scotland united to drive the steam automobile off the earth. They spread reports that horses dropped dead from fright when they met the steamers; that the boilers of automobiles frequently exploded with frightfully disastrous results; that the wheels of the heavy automobiles tore up the roads; and that the speed of steam carriages was so great that there was no safety for anyone traveling the same road.

Those original chauffeurs were arrested on the slightest provocation, fined, and imprisoned. Large piles of stone and huge heaps of gravel were placed on roads to make the automobiles "bump the bumps," and farmers' boys were hired to hide behind hedges and stone the passing pioneers of the horseless carriage.

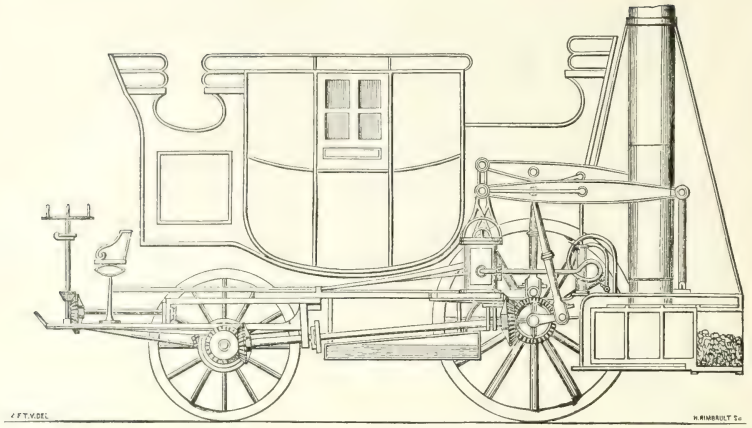
Some of those early automobiles—they all were "steamers"—carried an amazingly high boiler pressure. The ordinary steam pressure was 75 to 150 pounds to the square inch; but some of the crack automobiles, driven by their titled owners, carried boiler pressures running as high as 300 to 400 pounds. The chauffeur of to-day, who does his seventy and eighty miles an hour, is called reckless; but what would you call the man who, with the crude, experimental machine of seventy-five years ago, forced his boiler to carry 300 pounds pressure in order to reach the unprecedented speed of 20 miles an hour?—And there were no pneumatic tires in those days either.

Straddled a Steam Kettle

Those pioneer automobilists built their own machines. They had none to show them the "why" and the "how." Yet they straddled a steam kettle suspended from a springless frame, this kettle straining, throbbing, and vibrating with a pressure never before dreamed of; and they drove this crude machine with the roughest kind of steering gear, controlling the direction of iron-tired wheels over rough country roads, solving problems at the rate of twenty miles an hour. Taking everything into consideration, that is faster than the highest speed attained to-day by the up-to-the-minute racing cars.

When Motorists Took Long Chances

In the year 1831 the English parliament named a "select committee on steam carriages" to investigate the claims of the original automobilists that excessive tolls were levied against vehicles propelled by steam. The makers and owners of steam carriages rallied, and put up such a strong fight that the committee made a favorable report; but the toll road

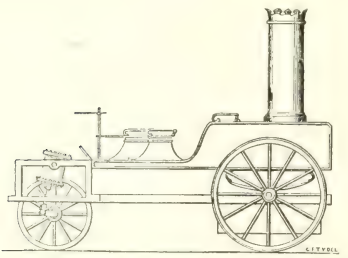


AUTO BUILT BY BURSTALL & HILL, 1824.

owners, stage coach companies, and farmers had the most influence, and none of the prohibitive tolls were removed. The evidence presented to this committee showed that when the automobilist of those days took his steam carriage for a day's run he also took large chances. One of the carriages ran into a farmer's wagon; and the angry agriculturist roused the country, mobbed the engineer, broke his machine, and compelled him to lay up for three days making repairs.

Stones for Auto Drivers

All over England the drivers, hostlers, post boys, and guards employed by the



WALTER HANCOCK'S AUTO-CAR, 1827, WITH OSCILLATING CYLINDERS.

big stage coach companies were banded together in an offensive alliance to do everything possible to prevent the development of steam motors. The favorite weapons of these gentlefolk were stones—large, round missiles, which were showered from behind the safe security of hedges upon the heads of the daring steam carriage operators.

Mr. Gurney, an eminent engineer, who built a steam carriage in 1827, was making a trip in his machine from London to Bath. At Melksham the stage coach people started a riot. Mr. Gurney was injured; and his machine was so badly damaged that, as he expressed it in his testimony, he "limped into Bath two days later."

All Autos Forbidden

Another engineer, a short time after, ran over a man with his machine; and the Court of Sessions promptly took his machine from him and entered a solemn order prohibiting the operation of any more such dangerous contrivances in that district, under severe penalties.

The automobile seems to have been born, in the form of an idea, in the year 1759, when a Glasgow student threw out the suggestion that the steam engine —then a very crude, low-pressure affair —might be applied to the moving of wheeled vehicles. This student afterwards achieved fame as Dr. Robinson, Professor of Natural Philosophy in the University of Edinburgh. Ten years later, Nicholas Joseph Cugnot, a French

engineer built the first automobile. The machine was a three-wheeled affair; and its course was quickly run, for on its second or third trip it turned a corner too fast and toppled over with a crash. The city officials of Paris refused to permit Cugnot to repair his machine. To keep it from harming anyone, they locked it up in a church, and there it stayed for some years.

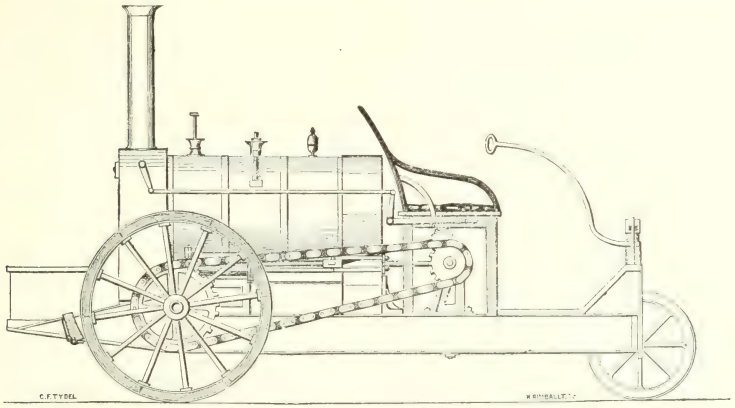
First of All Autos is Made

Cugnot's steam carriage, carrying four persons, made but two and a-quarter miles an hour; and its boiler was so small that after running ten or twelve minutes the steam gave out, and everyone had to climb down and wait until more steam was made. But this crude device, the first self-propelled vehicle ever made, demonstrated the fact that the student Robinson's suggestion could be put into practice. Several abortive attempts to apply steam wagons to use on common roads followed Cugnot's experiment; but it remained for Trevithick and Vivian, the Welsh engineers, to build a high-pressure locomotive and actually run it on rails and thus gain the fame which rightfully named them as the fathers of the modern locomotive. This was in 1804.

The first steam coach ever constructed expressly for the conveyance of passengers on common roads, was invented by Julius Griffiths of Brompton, Middlesex, England, in 1821, and was built for him by the celebrated Joseph Bramah (the "Patent Brahmin" of Sam Weller in Pickwick Papers).

Bump the Bumps in England

Sir Charles Dance was one of the most enthusiastic of the original English automobilists. He had a steam carriage built, which he ran between Gloucester and Cheltenham four times a day regularly for four months in 1831, during which time it carried nearly 3,000 people and traveled 3,564 miles. These trips were frequently interrupted by accidents to Sir Charles and his machine, caused by piles of stones which were purposely laid across the road. For a while Sir Charles fought prejudice and persecution; but, when parliament passed a bunch of anti-automobile bills, the titled automobilist gave up in disgust, after having made 315 successful runs with his machine.



AUTOMOBILE OF THE MARQUIS OF STAFFORD, 1859.
Weight, 2,134 pounds; speed, 16 miles an hour.

In that same year a steam carriage was made by Ogle and Summers, which got up a speed of 35 miles an hour. This machine used a boiler pressure of 250 pounds to the square inch, and ran over 800 miles without a single accident. According to a list published in 1834, of which the following is a copy, there were built or building in London and vicinity,

in December of 1833, the following steam carriages and drags:

Auto Output of 1833

Name.	No.	Description.
Hancock	1	Infant—his own; built; experimental one.
"	2	Era—for a company; built.
"	3	Enterprise—for a company; built.
"	4	Autopsy—his own; built.
"	5	A new one—building; his own.
Gurney, Stone, Gibbs, and Maudsley	1	A drag—built and altered by the said engineers for Sir Charles Dance, Kt.
Ogle	1	A carriage—his own; built; experimental one.
Squire	1	A carriage—himself and others; experimental one.
Fraser	1	A carriage—himself and others building; experimental one.
Gibbs and Applegath	1	A drag—themselves; experimental one; built.
Gatfield and Bower	1	A drag—themselves; experimental one; building.
Andrew Smith	1	A drag (for Mr. King)—experimental one; building.
Palmer	1	A drag—his own; experimental one; built.
Redmund	1	A carriage—experimental one; building.
Joseph Manton	1	A carriage—his own; experimental one; building.
Phillips & Co.	1	A carriage—their own; experimental one; building.
Silk	1	A carriage—his own; experimental one; building.
Smith & Co.	1	A carriage—for company; experimental one; building.
Mile End (name not known)		A carriage—for company; experimental one; building.

Touring Cars of 1860

This first automobile craze raged up to 1840; then the development of railroads and the opposition of stage coach and toll road companies killed the fever; but as lote as 1860, enthusiastic advocates of steam propulsion on turnpikes and common roads were touring England in steamers. In 1859 the Marquis of Stafford, assisted by some practical engineers, started a small steam coach on the turnpike roads in the north of England. The following account of the enterprise, published in the *London Times* of February 11th, 1859, gives some idea of the machine:

"The Marquis of Stafford is in possession of a new kind of steam engine for running on the road. It weighs little more than a ton, and is capable of traveling at from fourteen to sixteen miles per hour. It runs upon three wheels, and is guided by a handle in front, similar to a velocipede. The scheme appears to be a novel one in this district, and will no doubt be the means of opening a field for further inventions of the kind."

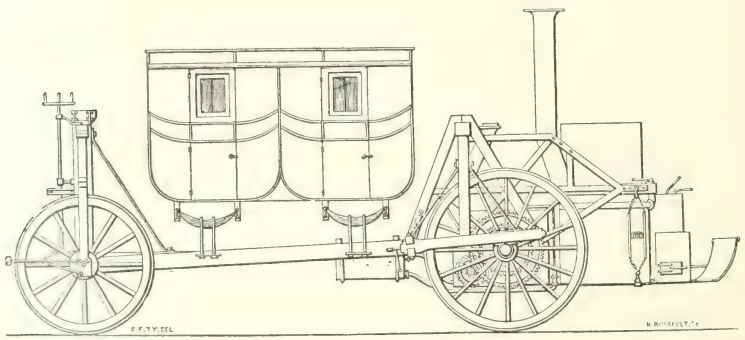
Ran Nine Miles an Hour

The *Engineer* (of London), in noticing the doings of this little engine, said:

"On Monday last (March 7, 1859), Lord Stafford and party made another trip with the little engine from Buckingham to Wolverton. His Lordship drove and steered; and although the roads from constant rain were very heavy, they were not more than an hour in running the nine miles to Old Wolverton. This is now the third trip the engine has made from Buckingham to Wolverton and back, twenty miles, beside other runs. His Lordship has repeatedly said that it is guided with the greatest ease and precision; in fact, Lord Sefton, who had not traveled with it before, drove it several miles.

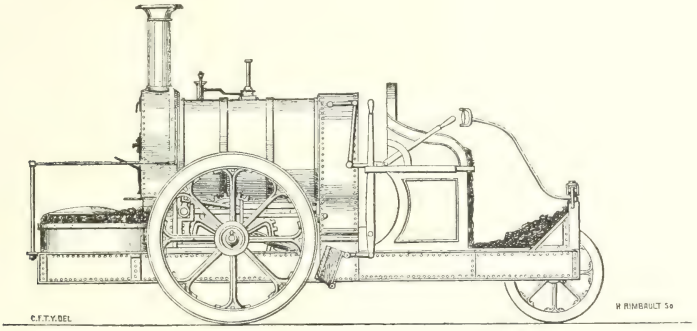
"It runs easy, being mounted on springs, and quiet, excepting the roar of steam from the blast pipe; and, as this can be shut off at will, but little difficulty has yet been experienced in meeting horses.

"It weighs 2,134 lbs. light, and 3,360 lbs. when fully loaded; and consumes six to seven pounds of coal per mile, and evaporates one



FIRST AUTO-COACH EVER BUILT FOR PASSENGER SERVICE.

gallon per minute. It was designed by the maker to run at ten miles an hour; one mile in five minutes has been attained, at which it is perfectly steady, the center of gravity not being more than two feet from the ground."

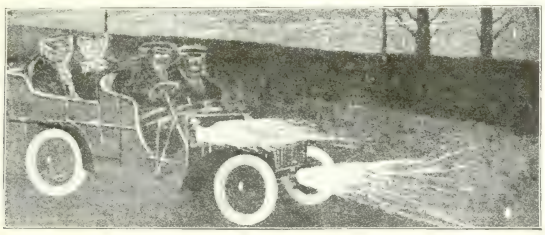


STEAM CARRIAGE OF EARL OF CAITHNESS, 1860.
Speed, 18 miles an hour.

Was a Great Hill-Climber

Although it had no sporting supplement, the *Times* had an eye out for good news, for, in its issue of August 1st, 1860, it copied the following report of an automobile run from the *Banff Journal*:

"The Earl and Countess of Caithness, and Mr. Ross, started from Inverness in his steam carriage. Owing to its being market day, the road was filled with horses and conveyances of all kinds; but the steam carriage passed through them all without any inconvenience to the general traffic or alarm to the horses. So perfectly was it under control, that it was stopped more quickly than an ordinary carriage and horses could draw up, which was done as often as there seemed any danger of horses being frightened. The run to Beauley, fourteen miles, was done in one hour and twenty minutes, including fifteen minutes for water, and numerous other stoppages. When there was a good length of straight road, eighteen miles an hour was done with great ease. The carriage went up hills, and down steep declivities, in the most satisfactory manner; and they reached Clashmore successfully the same day, after a run of near seventy miles. The carriage is being run over the steepest roads in Scotland, and is proceeding to Barrogill Castle, a distance of eighty miles."



SEALING VESSELS WORKING THROUGH THE ICE.

On the Floes with a Hair Sealer

Strange Life of 5,000 Hardy Men Whose Harvest Field is the Icy Coasts of Labrador

By NEWTON KIRKPATRICK

NEVER shall a man who has once watched the slaughter of a fur seal herd forget the grisly sight. From the deck of the blunt-nosed sealing steamer you can count thousands upon thousands of seal families stretched out on the glistening ice floes, the dark, mottled bodies of the adults standing out in high relief against the blue-whiteness of their floating homes, while the snow-white fur of the baby seals blends almost imperceptibly into the background. Out from the ship, hurrying over the ice, rush nearly 200 men of the crew, each armed with an iron-tipped club. From near and far go up the agonized cries of the terrified seals. Flopping along over the ice the adults rush frantically for the water, doing their best to hurry their young with them.

In most cases their way of escape is cut off by the sealers. With a blow of the iron-bound club, the skull of the seal-pup is crushed, its blood staining the whiteness of the floe, while its parents are allowed to get away in safety.

In a single day the crew of one sealer has killed 13,000 seals; and one season the sealer *Neptune* brought in a single ship-load which contained the bodies of 41,993 seals and was valued at $115,000.

But the hair sealer of the Labrador coast is more than a mere cruel butcher of defenseless baby seals. No men, anywhere, endure greater hardships, take greater risks, or display greater courage and resourcefulness than they.

Perils of the Sealer's Life

A hair sealer, caught by a fog or a blizzard on the floes, eight or ten miles from his ship, thinks little enough of a

SEALERS RETURNING TO STEAMER THROUGH A FOG.

walk of fifty or a hundred miles back to land over the half-floating ice. Often he does not win to safety. In 1898 the crew of the sealer *Greenland,* out of St. John's, Newfoundland — 180 men in all—were afar on the floes when a howling blizzard swept their ship out to sea and left them on the naked ice. When the *Greenland* was able to beat its way back, two days and nights later, 47 of them were frozen to death, and 63 others badly injured by the frost.

A GROUP OF NEWFOUNDLAND SEALMEN.

Fur Seal Not So Important

Because the fur seal of Bering Sea has been a grave international issue the past twenty years, and the subject of such reckless killing that he is now depleted almost to extinction, comparatively few are aware of the importance of his congener, the hair seal or ice-riding pinniped of the North Atlantic, whose habitat is the coast of Newfoundland and Labrador. Here every spring is prosecuted a seal fishery which, in the magnitude of its catch and value, far exceeds that of Bering Sea itself; for, during the eight weeks in which it lasts each year, some 250,000 seals are killed, which fetch $500,000, and there is no apparent diminution of the herds, despite centuries of this slaughter.

The Pacific seal is renowned for his fur, which is converted into one of the most fashionable of ladies' garments. His haunt is the rocky shores of the Pribilof Islands, and here the young are born, the families taking to the water when the "pups" are grown sufficiently to swim long distances. They are stalked on the beaches by the hunters, and also pursued when swimming, being speared or shot, this being the "pelagic" sealing which has provoked such friction between the nations interested in the preservation of the herds. A perfect skin

is valued at $10 to $12, and the industry is prosecuted by schooners from the United States, Canada, Japan, and Russia.

Value for Skin and Fat

The Atlantic seal is covered with hair, and is valued chiefly for his skin and fat, the former being converted into leather and the latter into oil. The females bring forth their young on the ice floes which every winter skirt the dreary Labrador seaboard, and the seal-ships seek for them there and kill them by thousands until the floes break up, when they hunt them in boats with rifles, as in the Pacific. The Scotch, Canadians, and New Englanders ventured into this fishery at various times, but each abandoned it in turn, none but Newfoundlanders appearing to possess the hardiness and daring essential to successfully traversing the unstable floes, whereon this unique industry is prosecuted, so that now it is a monopoly of the Terranovans, as it has virtually been for generations.

The earliest settlers of Newfoundland captured the seals in nets fixed along the coast, and converted the skins to varied uses. Later, men went off from the shore across the floes and hunted them there, and subsequently large fishing boats were used to chase the creatures among the open ice. In time stouter crafts were employed for this purpose, until about one hundred years ago a fleet of some scores of vessels was fitted out every spring for the seal hunt, this armada reaching its zenith in 1860, when it numbered 600 sail.

A SEAL ON A PAN OF ICE.

Steam Sealers Come In

Then, however, steam was introduced into the business, powerful wooden ships were built and engined, and their superior strength and propulsive force sounded the knell of the old-time "wind-jammers," so that to-day there is not a vestige remaining of that once splendid aggregation of sailing craft. The modern sealing industry is carried on by about 25 of these specially-built steamers,

A NEWFOUNDLAND SEALING CREW.

constructed of oak and sheathed with ironwood, to withstand the rasping of the jagged ice-masses through which they cruise, their bows several feet thick with solid timber and shod with steel bands that they may be hurled at the crystal barriers and batter their way through like a warship's ram. Their holds are traversed by beams and planks which will enable their sides to better resist a crushing arctic nip.

Used on Arctic Voyages

So staunch are these vessels that they are in general demand for Polar expeditions. Greely went north in one—the *Proteus,* and was rescued by two others —the *Bear* and *Thetis,* both of which are now American revenue cruisers on the Alaskan coast. Peary has had Newfoundland sealers for all his expeditions but the present one, and even now is using the *Erikasa,* supply ship. The Canadian Government chartered the *Neptune* to explore Hudson Bay and winter there. The British Admiralty purchased the *Terra Nova* to relieve the Antarctic expedition in the *Discovery;* and on reselling her in February last she was bought to convey a relief expedition to Franz Josef Land to seek for the Fiola-Ziegler party, which had been two years there and unreported, on a Pole-seeking venture.

Seal's Life History Uncertain

While many details of the natural history of the hair seal are at best merely conjectural, the story of his birth, habits, and migrations is among the most fascinating in zoölogical records. The seal, like the whale and the walrus, formerly abounded in the shoal waters near the Grand Banks; but now he has been forced farther north, though he has defied the attempts to exterminate him which have been well-nigh successful in the case of his larger kindred. It is supposed that during the summer he frequents the Greenland ocean, feeding on the fish life there; and that as that area becomes ice-clad he moves south. Early in February he leaves the open water and mounts the ice floes of Labrador, where the females deposit their young, which at the time of birth are covered with creamy fur, pallid as the snow-clad waste on which they lie. They are known to the seal-men as "whitecoats," and are the chief prize of the hunt, their fat yielding the finest oil and their skins the softest leather.

Instinct of the Seal Mother

The instinct of the seal is something marvelous. They select the same area every year to whelp in, and the "whelping ice" can be easily detected by experienced sealmen. The herds are of two species—"harps" and "hoods;" and the latter, which are larger, fierce, and solitary, and obtain their name from a cowl-like appendage behind their necks, are invariably found out further from land than the more peaceful and gregarious "harps," whose appellation is due to a lyre-shaped mark on the back. The mother seal, when she goes off at daylight to seek food in the waters below the icefields, will inevitably find her own offspring when she returns at sundown, and when sealmen have changed about some "whitecoats" to puzzle the creatures, the maternal instinct has sufficed to expose the fraud and send each mother to her own offspring.

Rapid Growth of Young

The young seals grow with amazing rapidity; at birth they weigh about five pounds, but within a month increase to about fifty, at which weight they are fit to kill, their coat of fat being three to four inches thick, though their only substance is their mother's milk during all that period. They are in their prime about the middle of March, and when that month opens the sealmen gather at St. John's to join their ships, about 5,000 men making up the crews. They sail on March 10th; and so eager are the fisherfolk to engage in the venture, that they will walk fifty or sixty miles, through snowdrifts and biting frosts, with kits on their backs, to secure "a berth to the ice," as the local parlance puts it. The tonnage of the ships averages 500, and the crews 200 men each, these being crowded into the forecastle beneath the bows. The holds are filled with coal, which is thrown overboard if she gets among the main herds and has a chance to fill up (coal being worth but $4 a ton and seal $80), but is consumed in cruising through the floes for scattered batches of the pinni-

peds if she is unlucky at the outset. An ample stock of food is also put on board, for occasionally a ship is "jammed" in

Sealmen Killing their Prey from Boats.

some remote bay by the ice and held fast till June, so that this contingency must be allowed for. Three years ago such a case occurred, and part of the crew left the vessel and walked 350 miles through the interior to their homes.

Main Herd off Belle Isle Strait

The main herd of seals is usually found off Belle Isle Strait, two or three days after leaving port, and the spectacle is a most extraordinary one. The hunters scatter in every direction, killing the young seals as they go. A hair sealer will often travel eight or ten miles from his ship, and as the men are divided into squads, or watches, each under a master, they will in such cases not attempt to drag their prizes back to her, but will heap them on a convenient "pan" or flat section of ice, surmounting the pile with one of the ship's flags, so that she may pick them up as she steams slowly along in the wake of her men.

Sometimes a herd will show a total of 100,000 seals within the range of a field glass from the crow's nest at a sealer's masthead, and several steamers will load from it in eight or ten days. When young seals are scarce, the old ones are hunted; and when neither is to be had honestly, the luckless ships are apt to loot the "pans" of their more fortunate consorts after nightfall, this theft of panned seals being a most prolific source of vexatious litigation every season. Perjury in sealing cases is a besetting sin with otherwise God-fearing people, and the prevailing view of the matter is epitomized in the declaration of a winning skipper to his crew: "Men! I'm proud of ye. Ye swore nobly!"

This seal-hunt is, however, no easy task. Added to the perils which every sealman must face—the loss of his ship, if not his life, by her wreck or stranding on a rugged shore; her destruction by tempest or collision, or her disablement by mishap to the machinery, the sealman has to guard against her being crushed by berg, floe, or pack ice, and against perishing himself as he traverses the floe far from her sheltering hold or works his boat through lanes of water, when a blinding blizzard assails him and no human agency can accomplish aught for his relief.

The sealmen are always abroad on the floes, when the weather admits, from sunrise till eventide, and, being usually miles distant from their ship, cannot get back if a storm arises. The hunting, killing, hauling, and panning of seals is most exhausting, for in the very nature of things the crews must remain the whole day without warm food of any kind, staying their hunger with sea biscuit, of which they carry a small quantity, while some will dine off a seal's heart, eaten raw and esteemed a great delicacy.

A Sealer and His Prize.

Strip Naked on the Ice Floes

When besieged by storms, belated by fogs, or benumbed by frosts, their splendid physique stands them in good stead,

LANDING SEALS AT ST. JOHN'S.

for they can endure hardships under which almost any other men would succumb; but they must labor without ceasing or become chilled and helpless, as they have to go lightly clad so that they may not be cumbered in their progress over the floes. When they fall through the ice and are immersed, they strip naked on the ice and wring the water from their dripping garments, donning these again then and trusting to the natural heat of the body to complete the process. When a blizzard besets them they contrive shelters of blocks of ice where possible, or cover themselves, if they can, with freshly killed seals, the inherent warmth of which helps to preserve their extremities against the deadly frostbite.

Frozen to Death on the Ice

In 1894 twenty-nine sealers perished adrift on ice floes, and in 1903 some twenty-six met a like fate. When searchers go out it is only to find the frozen corpses, and the half-masted flag at a sealer's stern and the ice-banked coffins in her waist, tell the all-too-familiar story anew to the island fisherfolk.

In the final stages of loading a sealer, the men's quarters are appropriated and the precious cargo stowed therein; and, during this period and the voyage homeward, the men have to live on the decks, sleeping and eating wherever they can. And as the waist is also piled high to the bulwarks with the pelts, boards being laid thereon, the condition of the men, from oil, coal, and grime, can be better imagined than described.

Olive Oil Made from Seal Fat

The south side of the harbor of St. John's is occupied solely by the "sealeries," large warehouses fitted up expressly for refining the oil and cleaning the skins. The sealers land their cargoes here, and expert skinners then separate the fat from the hides. The former is steamed into oil, purified and refined, and shipped to Europe and the States, where it is used as a substitute for medicinal cod-liver oil and for olive oil, as a constituent in high-class soaps, and as an illuminant in lighthouses, for which latter purpose it is the best known substance. The skins are cleaned of the adhering fat, grime, and hair, pickled, and then shipped to Dundee and New York, where they are tanned and converted into "kid" and "patent" leather for boots and like articles, while the past few years they have come into great demand for the making of bicycle saddles and kit-bags. The refuse is converted into guano, and the profits of the business are indicated by the fact that for ten months of the year the "sealeries" are idle and the ships also lying up, except when they are chartered for arctic voyages.

Safeguarded by Legislation

The industry is safeguarded by restrictive legislation, no ships being allowed to sail on the seal-hunt before March 10th, so that immature seals may not be killed, or to continue at it after April 30th, as in shooting the pinnipeds not more than one is secured out of every three shot, so the process is too wasteful to be tolerated. Only one trip a year is permitted, and sealing on Sundays is also penalized, a fine of $4,000 being imposed for every breach of these regulations. The business is ended by the middle of May and the men, who at most make only about $80 each, are released to engage in the cod, salmon, herring, and lobster fisheries, which occupy them during the summer months. The sealing fleet is owned by the great fishery firms of St. John's, and the business is conducted on the principle that they stand all risks, taking two-thirds of the catch in return, the remaining portion being divided among the men.

Wireless Signals Under Water

New Method of Guiding Liners along Dangerous Shores and of Communicating with Submarine Boats

By ROBERT McDUFF

ONE day about six years ago a young Bostonian, Arthur Mundy, varying the diversions of swimming on the surface of the water by diving underneath it, was impressed by the loudness of the report of a stone which zipped into the river a few yards away from him, tossed by a sportive small boy on the bank. With his head above water no stone had ever smitten his ears quite so strongly. Being the sort of person who thinks, it occurred to him that this peculiar sound-conductivity of water, of which he just had had striking evidence, might be put to practical use for signaling. Not being himself a scientist, nor having a technical education, he carried his idea to the late Prof. Elisha Gray. The submarine telephone was the result of their collaboration.

All Great Steamers Equipped

Of all the devices to prevent accidents to vessels at sea, the submarine signal bell is, perhaps, capable of the widest application. Apparatus to receive and to communicate sounds below water is now installed aboard all the great ocean steamships, the Cunard Line being the most recent (in July of the present year) so to equip its vessels. Even sailing vessels and privately-owned yachts are adopting the system. The sloop *Atlantic*, which won the Kaiser's Cup in the ocean race in May, was fitted with the device, and the steam yacht *Corsair*, owned by J. Pierpont Morgan, is so equipped.

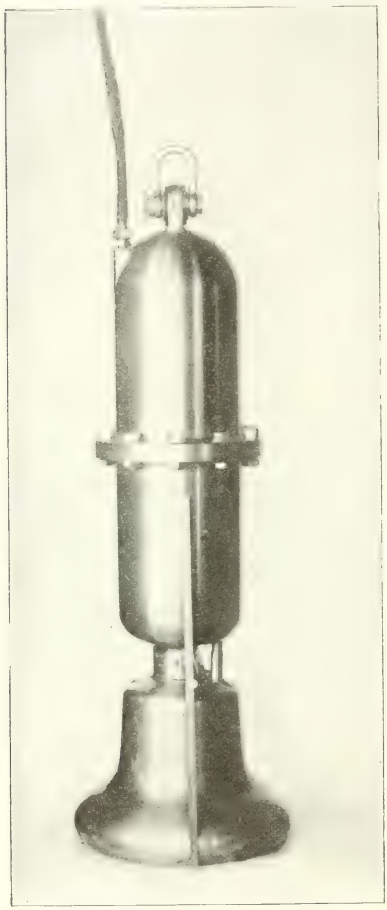
Principle Extremely Simple

The principle of submarine signaling is simple. Sound vibrations in the water travel at about four times the speed they do in air, or at a rate of 4,712 feet (almost a mile) a second, as compared with 1,100 feet a second in the atmosphere. These sounds can be heard for miles, whether they be caused by the action of the screws of a steamer, by the ringing of a bell, or in some other manner. The problem of the submarine telephone was to collect the sound-waves as they strike the ship's hull (every ship's hull is practically a drum) and then convey them to a receiving station—to the officer on the bridge, or the captain in the cabin.

METHOD OF SUBMARINE SIGNALING FROM SHIP TO SHIP, AND SHIP TO SHORE.

The collecting of the sound-waves is accomplished by means of a small tank

which is attached to the inner side of the skin of the vessel, the tank being filled with a chemical solution, denser than water, which contains a microphone.



Pneumatic Bell for Lightships.

(The microphone is an instrument for intensifying and making audible very feeble sounds.) A sound coming from the water outside passes through the ship's side and into the solution in the iron tank, no hole being required in the ship's hull for the purpose. The vibration, striking against the sensitive microphones, is converted into sound and carried by electric current along the wires which, attached to the tank, lead directly to the bridge or other receiving station. There are two of these tanks on each vessel, one attached on either side, and the greater volume of sound which comes through one than through the other indicates the position relatively to the vessel of the sound-producing medium.

Like an Ordinary Telephone

The mechanism by means of which the sounds traveling through the water, through the side of the ship, and along the wire are received and recorded in the pilot-house, resembles an ordinary telephone, except that instead of one receiver there are two. By holding first one receiver and then the other to his ear, the pilot can tell on which side of his vessel is the submarine bell which gives notice of danger, if he is approaching a coast provided with the system of warning signals; or he can tell in what direction, during a fog, another steamer is traveling, and by altering his course escape possible accident.

Sound Moves in Straight Lines

The explanation of the fact that the location of the bell or of the other steamer can be so accurately determined is that, curiously enough, sound will not travel around a corner under water, but moves in straight lines. In a report to the United States Navy Department, Lieut.-Commander Walling stated that the direction of a sumbarine bell can be determined within one-eighth of a point. The mariner's compass is divided into 32 points.

By means of a commercial code not only may warnings of danger be conveyed, but messages of information communicated as well. An officer of the *Kaiser Wilhelm der Grosse,* in a recent interview, said that when approaching Nantucket, about four miles distant from the lightship, holding the receivers to his ears, he caught the signal sixty-six —six bells, a pause, and then six more bells—the Nantucket Lightship code signal. When about the same distance from the Fire Island light, he caught the signal sixty-eight, the code number of that place; and again, approaching Sandy

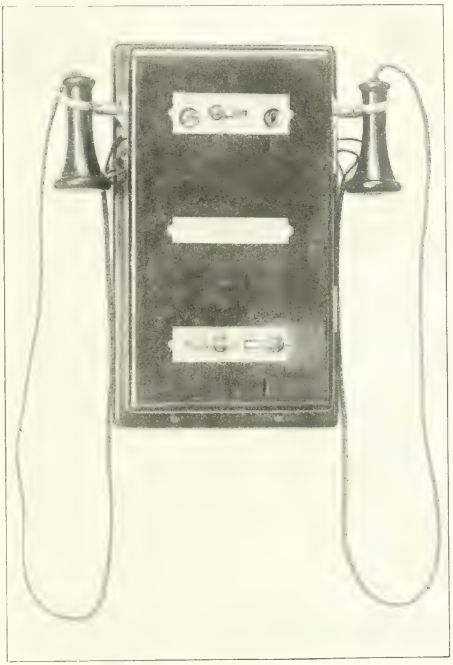
Hook, the Sandy Hook code number, fifty-one.

Protects Entire Coast-Line

By the use of a system of submarine bells the entire coast-line between New York and Halifax now sends out warnings for miles, and the same system is being adopted abroad and being extended in this country. The method of signaling now in use consists in ringing signal bells from all the lightships. These bells toll out the numbers of the different lightships, an interval of two seconds being allowed to elapse between each beat, four seconds between numbers, and six seconds before the code is repeated. The bells are anchored at selected points, and are rung by steam pressure and work automatically.

Used in Time of War

A use to which the submarine telephone may be put in time of war will be for communicating with submarine torpedo-boats, as well as for detecting the presence of the latter class of vessels belonging to an enemy. For the former purpose an instrument called a "multiple sounder" has been constructed. This has an alphabetical keyboard resembling that of a typewriter, a pressure on a key causing a set of hammers to beat on a diaphragm the Morse telegraphic sign for each letter. Anyone who can operate a typewriter can in this way send a submarine message. A special apparatus somewhat like a stock ticker would enable the message to be picked up on a submarine boat and printed on a tape. In the same way a message could be sent from the submarine boat and received at a shore station, or on the flagship of a fleet. A more simple way of sending messages would be by attaching a striking gong, or bell, to the side of a ship and tapping out a certain agreed-upon code.



Receiver-Box for Pilot-House.

Great Canals and Their Builders

I—The Grand Canal of China

By FREDERIC WILLIAMS

Formerly Editorial Staff, *Cosmopolitan Magazine*

DIFFERENT from all other great canals—as its country is different from other countries—is the Grand Canal of China. While Europe was settling down to the long lethargy of the Dark Ages, centuries before America was discovered, the Chinese began the construction of a waterway for internal communication which became and for many hundreds of years remained one of the engineering marvels of the world. Even to-day, perfected as engineering art has become, the Grand Canal of China excites admiration. No other artificial waterway of a period prior to the last half-century, is comparable with it. As an evidence of the canal-building skill of mankind fifteen hundred years ago, it is of unique present-day interest.

The hand of progress, so noticeable in almost all other countries, has been little felt in the China of recent dynasties; and the Grand Canal has fallen into the same neglect which has marked everything else in the Celestial Empire. The people who practiced many useful arts long ages before the rest of the world had emerged from comparative barbarism, have been smitten with a palsy of inaction; and engineering science, which demands inventiveness and application, has sunk to the lowest level. But the swing of the pendulum, marking the rise and fall of nations, the births and deaths of world-powers, seems now to be bringing China again into line in the march of progress. The evidences of her awakening are on every hand. In engineering alone, notable advances are being made. The Grand Canal, which ten or twelve years ago had fallen into such disuse that Sir Charles Beresford wrote of seeing pigs burrowing in its bottom below Soo-chau, is being repaired; and commerce, which had begun to be diverted to coastwise routes, is once more taking its way along its channel.

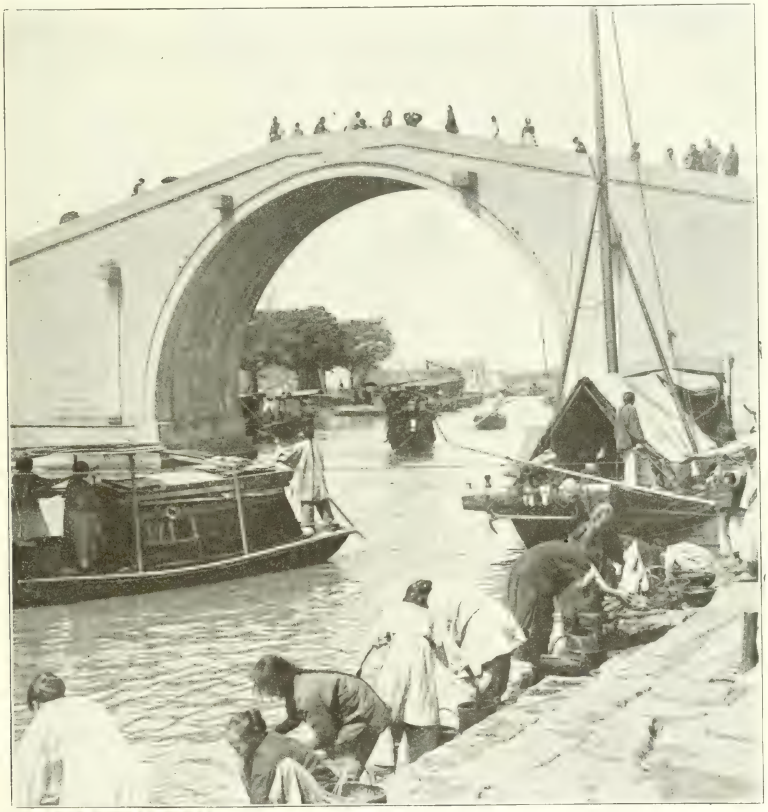
Almost twice the length of the Erie canal, or about 700 miles, the Grand Canal of China is by far the longest artificial waterway in the world. With its connecting rivers it links together parts of the empire which are separated by more than one thousand miles. It passes through one of the most thickly populated sections on the globe; and the variety of craft which navigate its waters is the most wonderful on earth. Large Chinese junks, with wide-spreading sails, alternate with little canoes sculled by a man standing in the stern; barges, laden with every kind of merchandise, drag their tedious journey past small slipper-shaped craft used as despatch boats, which can go everywhere, so little water do they draw; there are boats with paddle-wheels at the side turned by coolies who work within—a half-dozen or so on each vessel; boats owned by beggars, who sail through the canal from one town to another, anchoring in the channel while they go ashore to ply their mendicant trade; and boats filled with lepers being transported to some colony of their kind.

For ninety miles between the Hoang-ho and Yangtse rivers, the Grand Canal is an elevated waterway, carried over the country on embankments twenty feet high and of varying thickness. The canal along this elevated structure is about 200 feet wide, and the current runs at a rate of about three miles an hour. The mound of earth which supports the water is kept together by retaining walls of stone; and so stanch is the work that the lapse of centuries has seen no damage caused by break to the cities and towns which stand on the lower level along the route.

In just what year and by what ruler the construction of the Grand Canal was begun, is not known. That famous traveler, Marco Polo, says it was constructed by Kublai Khan (13th century); but other historians give it an earlier

date. At any rate, that part which lies between the two great rivers was made some time in the seventh century, by princes of the Tang dynasty; the channel from Lintsing-chau to the Yellow

facilitate the transport of tribute rice to the imperial granaries, due credit must be given to its projector for opening up so great a general trade route for the Empire. About 1,500,000 quarters of



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THE PICTURESQUE LAND OF CONFUCIUS.
Woo-men Bridge and Grand Imperial Canal, Soo-chau, China.

river was dug by the Mongols in the thirteenth century; and the southern portion was completed by the Chinese under the Ming dynasty, in the fourteenth century.

The conception and construction of the waterway give evidence of great mental breadth and skill; and, although one of the chief purposes of its building was to rice alone are transported by way of the canal from the southern provinces every year.

The Grand Canal, together with the rivers which it forms into a connected system of inland navigation, waters a plain which contains about 200,000,000 inhabitants. It serves not only for navigation, but also for draining and irriga-

ENGLISH BRIDGE TO FOREIGN LEGATIONS, CANTON, CHINA.
No Chinaman is allowed to cross without a permit.

tion. At one time, before the fury of the Taiping rebellion left alive but one-thirtieth of the population of a province, dwelling touched dwelling along the entire route; and such a collection of bridges of all types spanned the canal as the rest of the world could not equal. Then there was a continuous stone embankment, with a smooth granite curb, for 600 miles along the waterway, and on either side a well-kept road formed by the earth thrown up from the channel.

The route of the Grand Canal is from Hang-chau, south of the Yangtse Kiang, to Tientsin and Peking; and in its course it cuts both the Yangtse and Yellow (Hoang-ho) rivers, as well as several smaller streams. The channel varies greatly in width, in some parts following the beds of rivers, winding in and out for many miles without a lock. There is not a lock for 380 miles north of Chinkiang.

As the canal passes mostly through alluvial soil, the chief labor problem of the builders was in making the banks, rather than in digging the channel. In some places the bed was cut down from forty to seventy feet, but no great obstacles were encountered. The banks were formed by building stone facings, and also by using the natural soil in combination with the thick stalks of the gigantic native millet.

No machinery except that of the simplest character was used in digging the canal. With the Chinese, machinery is intended merely to assist and not to replace hand labor. Consequently the expenditure of human effort in the construction of the Grand Canal was enormous. Any estimate of the cost of the waterway would be a mere guess; but it is probable that if the labor had been paid for on a fair commercial basis it would have amounted to much more than the $120,000,000 required to build the Suez Canal.

Some of the work was performed in equal portions by soldiers, workmen, and the inhabitants both of the towns and rural districts. Each family within a cer-

tain radius was required to furnish a man of between fifteen and fifty years of age, to whom the Government paid nothing but his food. The soldiers to whom the lot fell to work on the canal, received an increase in pay, which was made up for by the specially hired laborers receiving no pay at all on certain days of the month. The method of operation was simply by hand shovel and bucket, horses and donkeys being used at times to convey the excavated earth to the bank.

In places where the soil was clayey, it was cut into blocks by shovels, and tossed from hand to hand by coolies standing in rows from the workings to the bank. Where the clay would not retain its form well enough to permit of tossing, it was carried in baskets suspended at the ends of bamboo shoulder-poles.

The contrivances for locks along the canal are very simple—stout boards, with ropes at each end of them, being let down edgewise over each other through grooves in the stone piers. Boats are dragged through and up the sluices by means of ropes communicating with large windlasses worked on the bank, which haul them safely but very slowly. Artificial basins were hollowed out in the banks of the canal at these locks, where boats might anchor securely. The sluices which keep the necessary level are of very rude construction. Soldiers and workmen are constantly in attendance at these sluices, and the danger to boats is diminished by coils of rope hung down at the sides to break the force of possible blows.

The canal is fed by innumerable creeks and rivers, the current flowing in one direction from the highest point (the influx of the Yun-ho), and in the other

A CANAL IN THE HEART OF CANTON, CHINA.

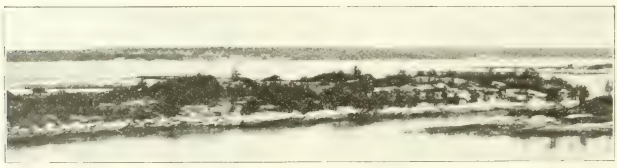
direction beyond it. Part of the water of the Yun-ho runs south, and part north; and a great stone facing has been built along the side of the canal opposite its inflow, to break the force of the current. Here a temple has been built to the Dragon King, or genius of the watery element, who has the canal in his keeping. To concentrate the waters of the Yun-ho and other rivers at this point, in order to secure an adequate supply for the canal, an engineer named Sung Li, in the service of the Emperor Hang-wu, in 1375, employed no fewer than 300,000 men at one time. He accomplished his object in seven months.

Much money has been set apart every year for the maintenance and repair of the canal; but, as a general rule, the appropriations have gone to line the pockets of dishonest officials. Of late, however, an improvement in conditions is noted, and the canal is being dredged at several places where it had become filled with silt. The disastrous invasions of floods from the Yellow river, which have diverted considerable of the former carrying trade of the canal to the Yellow sea, constitute still another phase of the problem, which is receiving attention at the hands of the canal engineers.

The opening of the interior waterways of China to foreign trade a few years ago, has done much to increase the commerce of the treaty ports, and is leading to a greater use of the Grand Canal. The imports of Tientsin, at the head of the canal, increased over 50 per cent during the decade 1894-1904. The right of foreigners to travel to all interior points for business or pleasure, and the privilege of navigating all streams with small steam vessels, are making their effect very noticeable.

Travel by boat is the most convenient and comfortable method in China; and throughout the basin watered by the Grand Canal there is so vast a system of natural and artificial waterways that there is scarcely a dwelling which may not be reached by a boat of some sort. Along some parts of the canal, steamboats are as yet forbidden; but the native house-boats, which are of all sizes, can be made comfortable. On the larger of these, where there is no competition with steamers, the fare asked is 185 cash (10 cents) a stage; and where competition exists, this is cut down to 133 cash (8 cents). In addition, however, wine money and incense money must be paid, the latter to propitiate the gods and secure good weather. Food is extra, and a sumptuous repast of rice will cost the diner two cents.

The endless lines of large red-painted vessels which Marco Polo saw on the Grand Canal, laden with cargoes of tribute rice and with silks and other products of the south for barter with the Mongols of the north, have given place to small junks and house-boats; but the number of these is legion. They all have one feature in common, and only one. That is the wide-staring eye, painted on either side of the prow, with which the boat is supposed to see. A friend who had traveled on the canal told the writer he had once got into trouble with a boatman because he sat with a leg dangling carelessly over the bow, the foot now and then swinging over the painted eye. How, indeed, could the boat go straight with its vision thus obscured!



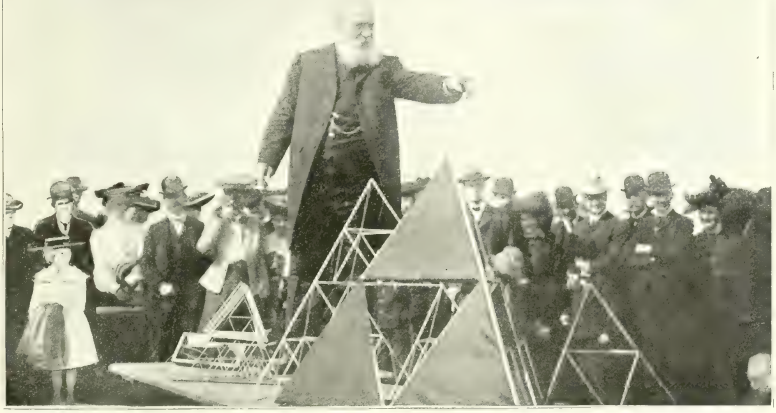
WHEN MEN WEAR WINGS

Despite the Croakers the Great Problem is Already Solved in Principle.

by

GILSON GARDNER

Washington Commissioner The Newspaper Enterprise Association



IT was during a recent interview with Dr. Alexander Graham Bell, the distinguished inventor of the telephone, that the fact dawned upon me, in its full significance, that the day of mechanical flight is actually upon us. The flying machine is no longer a dream, a possibility, or even a probability; it is a fact, a demonstrated actuality, an accepted scientific phenomenon.

I do not speak of dirigible balloons, which are well enough in their way, and which, by reason of their size, seem always to fill the popular eye to a larger extent than their importance warrants. Flight by man, if it is ever to amount to anything, must be the flight of a body heavier than air, lifted and propelled by mechanical operations similar to those of the birds. This is the flight of which man has dreamed since the time of Dædalus, and which has numbered among its prophets such familiar names as Sir Hiram Maxim, S. P. Langley, General Baden-Powell, and the brothers Wilbur and Orville Wright. These all have announced their faith in man's ability to construct an apparatus, driven by an engine, equipped with wings, and capable of continued passage through the air, with a man aboard controlling and directing its movements. This is the kind of flight which has been achieved, and which is destined sooner or later to fill its part in our daily life.

From the theory to the model, and from the model to the full-sized machine, this invention has progressed. At first the scoffers said the theory might be plausible, but that it never would progress beyond the theory. Then a model flew. Was this sufficient to convince? Not against the skepticism based on nineteen hundred years of failure. The unbelievers said the element of size was an obstacle to artificial flight which would chain man forever to the ground. And a solemn law of mathematics was adduced in confirmation—weight increases as the cube, while supporting surface increases as the square of the increased dimensions. Could this be denied? No. Then to Limbo with your dreams!

Then two mechanics in a small Ohio town brought together the three elements to success—a light and powerful motor,

PROF. S. P LANGLEY, SECRETARY OF THE SMITHSONIAN INSTITUTION, AND INVENTOR OF THE FIRST SUCCESSFUL MODEL FLYING MACHINE.

A full-sized reproduction of the model was constructed under his supervision, by the Government authorities, but it has not yet been successfully launched.

wing-like surfaces of sufficient spread to support some 350 pounds, and, with one of the inventors in the saddle, the apparatus skimmed the air, free from the ground. A brief notice appeared in the daily papers; a few highly imaginative pictures were furnished by the latter's "art departments;" and the matter passed from memory along with the numberless "fakes" which had preceded and have followed. Almost two years have passed; and any inklings of credulity which might have been aroused by that announcement have been lulled to sleep by the failure of the expected sequel. Without an ocular demonstration, or at least a page or two of photographic illustration, the heralded success of a flying apparatus finds no general credence. In all matters of aviation, the public has adopted the "show me" policy of Missouri. Which is natural, perhaps, and quite inevitable in the light of past experience.

But in this, as in other matters, the still, small voice of Truth will find its way amid the din of Sunday supplements, and will be recognized by her own. Without photographs or other publication, the whole world of aëronautical science knows that the victory has been won. December 17, 1903, is the date which History will set down to mark man's mastery of the air; and the names of Wilbur and Orville Wright, of Dayton, Ohio, will be chronicled as the winners in this race for fame.

But where is the machine?—the impatient public asks. If this is not a fake, why not let us see? Why should we believe the impossible on the bare statement of a man we do not know? Other inventors are glad to announce their discoveries to the world.

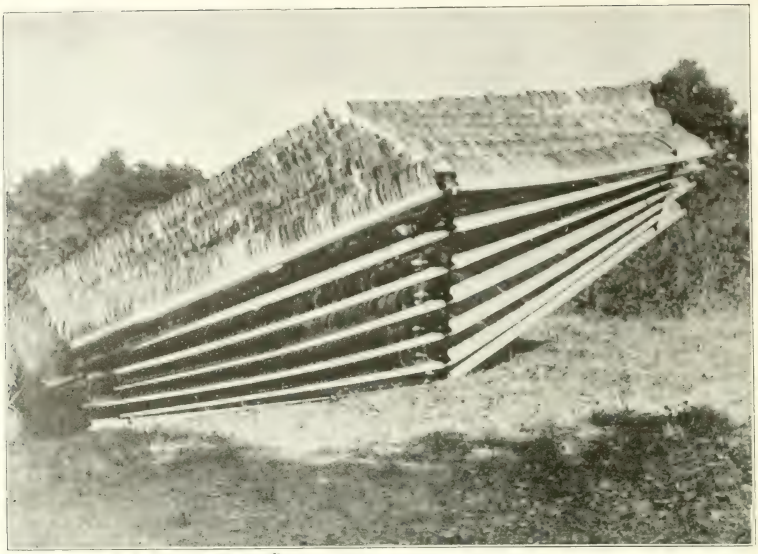
Yes. But other inventors are not working on an engine which may revolutionize the art and practice of warfare. The press grew furious with Prof. S. P. Langley because he would not tell all about a machine whose secrets were the property of the Government, and whose tests were conducted under the supervision of a joint board of the Army and Navy Departments. The secrets were not his to divulge; and the Government had the same reason for desiring privacy which causes the authorities to exclude the world at large from the vicinity of the mines planted in the Potomac river at Fort Washington. The inventor of the successful flying machine will find the War Department at Washington his first and most generous patron. It will probably pay him better to sell his secrets to the United States than to make them public through the Patent Office, even though he should thus secure a monopoly of their commercial exploitation.

The Wright Brothers' Aëroplane

So much, then, for the reasons for not displaying the first successful flying machine to assembled multitudes. The test to which reference has been made, of the Wright brothers' machine, took place on the sand dunes of Dare County, North Carolina. The apparatus was an aëroplane, similar in its general scheme to that built by Prof. S. P. Langley. It flew 852 feet against a wind of nearly 25 miles an hour, remaining in the air 59 seconds. The speed was about thirty-five miles an hour through the air, or ten miles an hour over the ground. Three other flights were made, all shorter than the one described. The machine was launched from a mono-rail laid on the ground, receiving no assistance from gravity or otherwise, but being started and propelled entirely by its own power. During its flight it was under the complete control of the operator, who intentionally refrained from rising higher than eight feet from the ground.

Since the brief announcement of the above facts, the Wright brothers, as I have been credibly informed, have been at work perfecting the invention. For good and sufficient reasons they have declined to make public any further results of their labors, or details of their machine. So the public must be content to wait.

The importance of the unspectacular achievement above set forth, is found in the fact that this was the first time in the history of the world that man has navigated the air in a machine heavier than the air, propelled by its own power, and subject to the control of the operator. Models of such a machine had flown, the first being the steam-driven model of Professor Langley, successfully tried in



IRISH AËRIAL SAILING CRAFT.—TOP VIEW.
A two-man capacity aërial sailing craft.

1896. Full-sized machines—that is, having wing surface sufficient to support the weight of a man—had been used to soar upon the wind, but they were without motor or propellers to give them a momentum of their own. They were dependent on the wind, or the force of gravitation, and their action was a species of "sliding down hill" on the air, rather than of flight. It remained for the brothers Wright to take the machine with which they had been "coasting" on the air, and to equip it with a pair of propellers and a gasoline engine, light and strong. It was their patience and ingenuity, as it appears, that succeeded in building a surface structure strong and light enough to carry a man and a motor, and to build a motor light and strong enough to propel the heavily loaded wing-like planes. In so doing they took the important step from the working model to the one-man-carrying machine.

The Langley Aërodrome

It will be recalled that it was this step which Professor Langley was essaying to take in the fall of 1903, with the large aërodrome unsuccessfully launched from the roof of a house-boat moored at the mouth of the Potomac forty miles below Washington. The account of those experiments, which Professor Langley has only recently prepared, shows that the machine was crippled before it left the ways, and never really had a fair trial of its powers of self-support. The launching mechanism proved to be impracticable; and the failure of the fund set aside by the War Department has prevented any further effort to renew the trials. The aërodrome has been repaired, and—its inventor claims—is ready at any time to show its powers. The Wright machine was launched from the level ground, being started on a single rail; and this method is favored by Professor Langley as a substitute for a leap from a roof of a floating scaffold or other structure.

The Problem of Safety

What is the next step? To make flight safe. But again the voice of the skeptic is heard. Still unbelieving, he says this fuss and pother is all to no effect, for it but increases the percentage of casualties among cranks. The enormous speed, the

frail character of the apparatus, entailed by the ever-present demand for lightness; the inevitable pull of gravitation, dealing the penalty of instantaneous death to one who suffers any character of accident—these must combine to make but an empty form of man's seeming triumph. The difficulty of launching and the dangers of landing, the doubters are assured, will never be overcome; nor will man ever acquire a skill adequate to meet the vicissitudes of the impalpable and treacherous air.

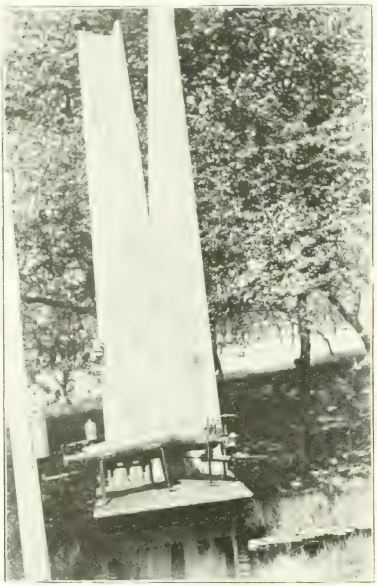
It is not the purpose of this article to indulge in a theoretical defense of the possibilities of aërial navigation; but one cannot help recalling that similar obstacles and dangers were conjured up for the railroad and the steamboat. The realities of to-day would have seemed but the wildest dreams to the people of the stage-coach generation; and perhaps in the matter of navigating the air, the dangers have been overdrawn. When a man is willing to be dragged 4,000 feet into the air by a hot-air balloon, and to trust to the wings of an aëroplane for a descent from that height, it is an indication that some advance is being made toward the safe use of such mechanism. This was the somewhat spectacular method employed by Professor Montgomery, of the Santa Clara (California) Catholic College, for demonstrating his achievements in the direction of making a supporting surface stable and subject to the operator's control. The first test, which took place March 26, 1905, seemed fully to justify the Professor's confidence; the second resulted in the death of the aëronaut who made the ascent.

Bell's Tetrahedral Kites

Perhaps the most important work in the direction of securing safety for mechanical flight is that in which Professor Alexander Graham Bell has for several years been engaged. This distinguished inventor has departed somewhat from the paths of Langley and Wright, and has been devoting himself to what might be termed a "butterfly" flight. This is his designation; and it serves well to describe the difference between his method

SENDING UP A SMALL TETRAHEDRAL KITE.
Experiments conducted by Professor Alexander Graham Bell, near Washington, D. C., in the evolution of a safe type of flying machine.

and the others. He takes the butterfly for his model, while Langley takes the eagle. This statement should not, however, be understood too literally, for neither undertakes to reproduce either creature in any mechanical detail; but the two methods of aviation are typified by the butterfly on the one hand, and by the eagle on the other. Eagle flight is marked by its strength and speed; the butterfly hovers lightly over the earth, gently rising or alighting, unambitious, but safe. Perhaps, thinks Professor Bell, man would do better to imitate this kind of flight in the first trial of his mechanical wings. An initial velocity of sixty miles an hour cannot be acquired by the new experimenter, without danger to his life and limbs, not to mention his fragile apparatus. Is there not some way by which we may learn to fly more gently?



Linen Wings with One- and Four-Impulse Gasoline Motors for One-Man Capacity Machine.

If the ordinary butterfly were greatly enlarged, and its wings were braced across the back so they would remain rigidly spread out, it would make an excellent kite. Just attach a cord to the upper part of the body, and it would soar upon the air current in most satisfactory fashion. Not so an eagle. There is probably no bird which could be converted into a practicable kite. The weight is always too great in proportion to the area of sustaining surface.

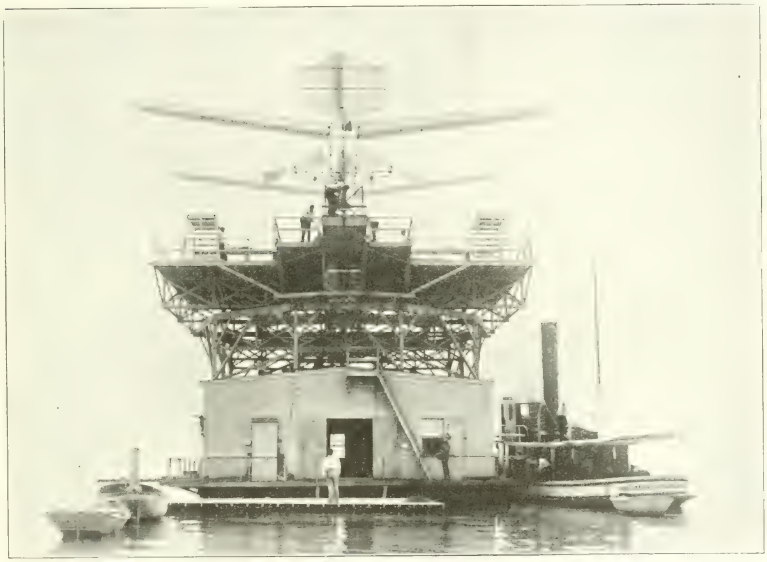
"Projectile" Flight

What then? Is there a difference in the principle of support between a surface, like that of a kite, which is held stationary against a moving current of air, and another surface, like the outspread wings of a soaring bird, which moves itself against the still air? Undoubtedly. There are some things about flight which are not at all clear; but it is becoming quite evident that the various equations which describe the supporting power of the superficial wing surfaces, do not tell the whole story. Professor Bell has a theory that momentum plays a large part in the flight of the relatively heavy birds and insects. It is possible, he thinks, that there is what might be termed "projectile" flight. The momentum of an arrow, or of a cannon-ball, causes it to "fly" through the air, overcoming for a time the attraction of gravitation. Is it not possible that some of the heavier flyers use their wings to project themselves through space, and that a large proportion of their flight might be conducted as well in a vacuum as in air? When closely observed, smaller birds are seen to "reef" their wings, drawing them in close to their bodies, so that the momentum acquired by the initail violent beatings against the air, may not be retarded by air interference. Flight of this sort is a succession of projections, for which the air furnishes the leverage for the initial impetus, rather than any continuous support.

But "projectile" flight is evidently not the simplest method of traversing the air. The butterfly does not employ it. Here is a creature whose wing surface is so large in proportion to the weight of its body, that it may be said to be continuously supported by the air, on principles similar to those which cause a kite to remain aloft. This continuous support is accomplished at moderate rates of speed. Here, then, is the safe model for man, providing he can emulate the strong, light

construction of the butterfly wing. And it is to the evolution of such strong, light construction that Professor Bell has turned his attention.

Two years ago Professor Bell read a paper before the National Academy of Sciences, at its annual meeting in Washington, on the subject of tetrahedral kites. This article, with experiments since conducted, represents the results of some six years of labor, of which the



LARGE REPRODUCTION OF PROFESSOR LANGLEY'S MODEL FLYING MACHINE.

outcome is a new style of construction by which the supporting surfaces to be employed as the wings of a flying machine may be built up with butterfly lightness and strength. Recent experiments have been made to determine what general form the entire structure should have, in order to insure the largest possible measure of stability in the air. As a result of these, an exceedingly stable form has been discovered; and it has been found, in addition, that it may be built up to almost any size without disproportionate increase in weight. In fact, while the weight increases as the cube of the increased dimensions, the area of the supporting surface increases in practically the same ratio. By this change of these two ratios, Professor Bell disposes of one of the chief obstacles to the construction of large-sized machines for navigating the air.

Practical demonstration has been given of the utility of the tetrahedral unit in building giant kites. On one occasion a kite of this type flew in a moderate wind, carrying up a weight equivalent to that of a full-grown man and a 200-pound motor. Experiments with the large structures and heavy weights are being continued, with a view to determining the exact size needed to support the weight, and the style of structure best adapted to control by the man who will go up with it. When ready for its final test, this flying machine may be sent up like a kite; and when it has reached any height desired, the motor may be started, the kite's own momentum through the air being substituted for the movement of the wind against the surfaces which hitherto were held stationary by the flying line.

An important feature in the experiments with these giant kites, is the gentleness with which they land. In practically any wind, even the lightest, they may be reeled in directly to the hand. This will be found to be an important feature when they begin to carry passengers.

It is not anticipated that this "butterfly flight" machine will develop an enormous speed. Its course against the wind would necessarily be slow. To attempt to drive so light a structure, containing so much resisting surface, through the air at the speeds of eagle flight, would be followed quickly by a smash. But what is sacrificed in speed, is gained in safety, which, in the present stage of aërial development, is a consideration of some importance. Nor are very high speeds greatly to be desired, providing the machine is able to make its way against an average fresh wind; and this, it is anticipated, such a machine could easily do. The power to maintain continuous flight, for a number of hours, at an average rate of advancement of 35 miles an hour in still air, would insure a perfectly practicable machine for war or other purposes. Experiments with the tetrahedral structures of Professor Bell show that such a speed could be maintained without risk.

Mechanical flight, then, is an accomplished fact. Safe mechanical flight appears as a near prospect. What then? This is the day of the one-man-carrying machine. Will invention stop and turn back? Automobilism developed the light and powerful petrol motor, which is almost equivalent to the discovery of some new force; the inventor of the telephone has added a new unit of structure, which is equivalent, almost, to the discovery of a new and light metal; now inventive thought is solving questions of safety and control. Is this not the day of mechanical flight?

Dinner-Pail Philosophy

¶ Little sins never stay small.

¶ A wrong is always worth forgetting.

¶ The fear of man is the beginning of stupidity.

¶ When a so-called vocalist murders a song it doesn't deaden the sound.

¶ A small man dwindles before great opportunities.

¶ If you would have your money reach those who are needy, buy poetry with it.

¶ Education does not consist in knowing a lot of unnecessary things.

¶ When a fellow gets to be boss—well he'll do about as his boss did. Sometimes worse.

¶ There is always room at the top if you can push the other fellow off.

¶ A good woman is usually too good for any man—but fortunately she doesn't know it.

"Which Branch of Engineering Shall I Take Up?"

No. 1. Hydraulic Engineering—An Interview with Lyman E. Cooley

By JOHN L. RAY

LYMAN E. COOLEY.

Within recent years engineers have specialized along many different lines. The result has been the development of as many practically distinct branches of the profession. Doubtless there are young men, who, having decided that engineering shall be their life work, are hesitating as to which branch they shall take up—Civil, Mining, Mechanical, Hydraulic, Chemical, or any one of a dozen other divisions.

The series of articles under the above head—of which this is the first—is intended to help them come to a wise and discriminating decision. The articles will be based on interviews with eminent engineers, each of whom will set forth the advantages and drawbacks of his own particular specialty. In the present instance, Mr. Lyman E. Cooley paints a graphic picture of the opportunities which lie before the hydraulic engineer. Mr. Cooley was the promoter and originator of the great Chicago Drainage Canal, and, among other important works, had much to do with the reconstruction of the Erie Canal.

ENGINEERING in its proper sense is the work of a pioneer. It is the application of first principles to new conditions. In some of its branches, Mr. Cooley points out, engineering is losing this characteristic and becoming little more than skillful shopwork. But of all the divisions of the profession, he believes, hydraulic engineering will longest retain its old pre-eminence. For this he assigns several reasons. Climatic conditions, rainfall, and precipitation will not be the same in different localities. Geological formations will be different. New conditions will be met, and special applications of principles will have to be made in dealing with each.

Hydraulic Engineer Came First

It is an interesting speculation that hydraulic engineering was the form which the earliest human activity in the construction of works may have taken. It is conjecture, but conjecture based on reasoning, that the nomads of prehistoric times came to their first permanent abodes at the sources of water power. It being assumed that this was the case, some effort to utilize, direct, and store this water supply may be assumed as a corollary.

When the first communities were being gathered together in Asia Minor and in Mesopotamia, it may be conjectured that hydraulic engineering was the science in which the most progress had been made; and this conjecture is given basis by the explorations of archæologists.

Joseph an Early Engineer

It is a further conjecture of antiquarians, a somewhat flippant conjecture, that Joseph was a hydraulic engineer; that the Biblical seven years of plenty and seven years of famine were due to a manipulation of the water supply. To substantiate it the antiquarians derive the name "Yousef" or Joseph from the word meaning "water carrier."

It does not need the aid of conjecture to give antiquity to the profession of the hydraulic engineer, and it does not require imagination to indicate the field open to the hydraulic engineer in this country, a field only partially developed now.

Branches of Hydraulics

Mr. Cooley would divide these opportunities into five broad divisions, which may be considered as follows:

The creation of irrigation systems in arid and sub-arid regions.

The establishment of water supply for cities.

The development of water power.
The creation of waterways.
The storage of water in humid regions.

It illustrates sufficiently the magnitude of the first field, to point out that on 800,000 square miles of this country there is not sufficient waterfall, naturally, for two out of five crops. The area which can be reclaimed is estimated as sufficient to support from 30,000,000 to 40,000,000 of people.

Farmers Going to Canada

In this connection it must be remembered that the farms of the United States are increasing in value to such extent that the farmer with a family of boys, to each of whom he would like to leave a farm, is considering, seriously, the proposition of selling his high-priced land and moving into the Canadian Northwest, where he can buy farm land equally as good for one-tenth the price for which he can sell his own.

Not only are the farmers considering it, but they are flocking into Manitoba and the Canadian Northwest in ever-increasing numbers. It remains for the hydraulic engineer to deflect this tide of emigration and turn it to the sub-arid lands of the United States, which, with a properly regulated water supply, are made as profitable as, if not more profitable than, the lands of the humid regions where no science is expended on the control of water.

For generations there will be work west of the hundredth meridian for the engineer. The field is limited only by the possible supply of water.

With the development of sanitary ideas, not only the big city, but the small town gives its attention to the establishment of a water supply. This, which has been the problem of the city, has become the problem of the village and small town. The pump, with its inherent dangers and its offense to sanitation, is being recognized as inadequate, as well as possibly dangerous.

This field of industry is only partially developed for the engineer. The problem of supplying these villages and small towns with a gravity water supply from streams, is for the next generation of hydraulic engineers to solve.

A third field includes the development of water power. Here the hydraulic engineer stands only on the threshold of what is to be accomplished. Already there is a decided activity in this direction, but it is only the beginning.

Vast Future of Water Power

"There is enough water power in this country," says Mr. Cooley, "to turn every wheel for every industry in the land. Not only that. There is enough water power, properly developed, to heat every home and cook every meal in the country. The water power of the country is higher in value than any mineral resource, and the development of this resource is only in its infancy."

The fourth field for the hydraulic engineer is another into which he as yet has hardly more than stepped—the development of waterway systems.

Here, as in all other forms of engineering, it is necessary to call attention to the economic character of the engineer's work. An engineer is always an economic force. He is always dealing with economic questions, as much as he is dealing with physical questions. He is making possible the production of something.

Waterways to Be Built

The hydraulic engineer engaged in the creation of a waterway system is distinctly engaged in handling an economic subject. It is one which has been fully recognized in France and in Germany, while in the United States it has not been heard to any extent. In France and Germany, the railroad and the waterway are developed in common. France has waterway systems to one-third the mileage of her railroads.

In the United States, from the Alleghanies to the arid regions, at about the hundredth meridian, lies the country which can be chiefly benefited by the development of waterway systems, a country which such hydraulic engineers as Mr. Cooley hold is entitled to as great expenditure in such development as was expended in the building of railroads.

"This is to be our next great move," says Mr. Cooley. "The railroad has become too expensive a factor in transportation. We must find a cheaper means for the carrying of the great basic necessities of our life. If we are to maintain

permanent supremacy we must develop our waterway systems. We have been only scratching the surface in a chaotic sort of way. In this form of hydraulic engineering there is a field of usefulness for a century to come."

For the Storage of Water

While the conservation of water in arid regions presents an immediate problem, the storage of water in humid regions presents one which will be faced some time in the future. The hydraulic engineer will be called in to store the floods of the humid regions and to equalize the flow of water for navigation and power.

As an economic proposition, the storage of water in the humid regions is only less valuable than its conservation in the arid regions. There is intrinsic value in the lakes and reservoirs, aside from the value they possess for fish culture and because of their beauty.

In China an acre of water is as valuable as an acre of land in the production of food. In Illinois the value of the Illinois river in the fish taken from it is as great per acre as the value of Illinois farm land.

To Reclaim Swamp Lands

In addition to those five fields which have been considered in brief, a word might be said of the work which is to be done by the hydraulic engineer in the reclamation of swamp and wet lands and in the protection of alluvial lands against overflow.

The interest which the technical student or the young man considering a technical training will find in these subjects, will be based on the fact that they are in a state of development. The opportunities in them will be greater when he has completed his study than they were when he started in.

They will be developing with him, and they hold promises which will last his lifetime.

At Fourscore

CALL her not old, although the flight of years
Has measured off the allotted term of life!
Call her not old, since neither doubts nor fears
Have quenched her hope throughout the long, long strife.

They are not old, though days of youth are fled,
Who quaff the brimming cup of peace and joy!
They are not old who from life's hidden springs
Find draughts which still refresh but never cloy!

For what are years, though flying ne'er so fast?
A year's a day if full of gladsome zest!
But who shall measure time, when hopes are past?
A day's a year if sorrow is the guest.

The secret of perpetual youth is hers
Who finds delight in deeds of kindness wrought;
No age can dim the luster of her crown
Whose days with loving ministry are fraught.

F. E. Snow in *The Outlook.*

How a Brown Hero Died

Dauntless Devotion to Duty Displayed by an East Indian Civil Engineer in the Desolate Hinterland of Asia.

By JOHN LA CROSSE, M. D.

WHEN the story of all the heroes comes to be written, men who have followed the profession of engineering will fill a large place in the book. They are men whose names one rarely sees in the newspapers; to them no Carnegie medals are awarded, though they have risked their lives and, mayhap, lost them in a dauntless devotion to the duty which lies nearest at hand.

Witness one Mohi-ud-din, a poor, brown East Indian civil engineer and surveyor—servant of the British Seistan Boundary Commission. Seistan, as one may find on the maps, is the name of a great stretch of wild, desolate, unexplored country lying in the hinterland of Asia, up somewhere between British India and Afghanistan. An awesome land is Seistan. For months at a time it bakes in a sweltering, dry, burning heat, while during the same months a hot sirocco blows across the parched land with the fury and swiftness of a Western cyclone. This wind is known as the "120-day wind," and it reaches the velocity of 120 miles an hour, as measured by dependable instruments.

Answers the Call of Duty

It was necessary for the peace and comfort of the great British Foreign Office, that the boundary line of Seistan should be accurately surveyed and laid out. For that work a commission of civil engineers was appointed, serving with them, as one with technical skill to do the work and personal daring to undertake it, Mohi-ud-din, unknown to all but a few English officials.

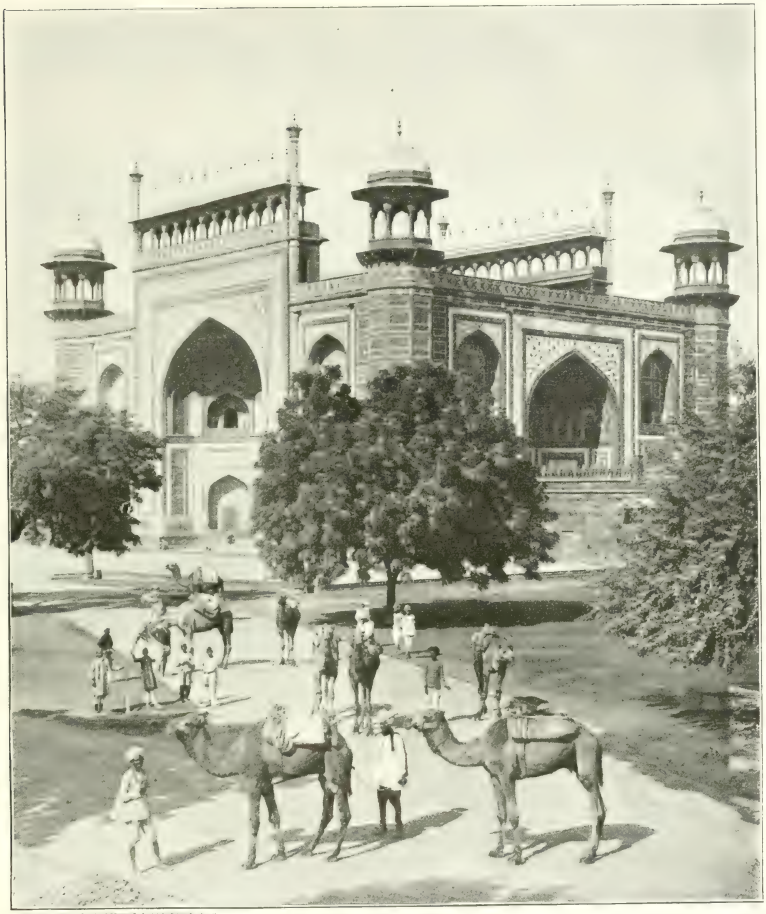
While in Seistan, he was ordered to explore and map out the Dasht-i-Margu, a very forbidding desert between the Helmund and Kash rivers; and in June, 1903, in spite of the extreme heat, he struck out from a point west of Rudbar on the Helmund, on a course nearly due north, his party consisting of four survey assistants, four Afghan guides, and two camel men.

Wander in a Waterless Desert

They marched all night, called a halt in the early morning, and continued the march during the day. At nightfall the water carried by the camels had given out, and the guides urged that either the return journey should be begun at once or a route taken due west, so as to strike the northern bend of the Helmund. Mohi-ud-din, however, was determined to push on, and a guide was sent off on a camel to find water. He returned with a leather skin full, but it was so brackish that those who drank it fell ill and could not eat their food. The party had then to march on, and they were fortunate enough to reach another well where a small supply of drinking water was obtained.

Tie Themselves on Riding Camels

At midnight on the 14th they started again, still steering northward, and at daybreak they halted on a high desert plain. There was no sign of water, and, the position being critical, Mohi-ud-din reluctantly recognized the futility of further exploration. He agreed to return, but by night, after great sufferings from thirst, two of the guides became insensible. A third guide, Sultan Mahomed, tied each of them upon a riding camel and himself on a third camel. The animals were then linked together and left to go whither their instinct would lead them. Sultan Mahomed fell unconscious



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CAMEL DRIVERS WAITING TO START FOR THE SEISTAN COUNTRY.

during the night, and remembered nothing till he came to through water being poured down his throat. He and his friends had been rescued by a hunter who had wandered into the desert in quest of wild asses. The party were within an ace of death, but were taken to Chakansur, an Afghan village on the Kash river, and under careful treatment recovered.

The rest of the party under Mohi-ud-din met with a melancholy fate. They were too weak to march, and the first to die was a camel man, who wandered into the desert and never returned. The others remained all night with Mohi-ud-din, and in the early morning, seeing he was nearly dying, they crawled to a ravine close by and dug for water. No spring was found and their only relief was to throw the damp earth over their bodies. In the evening some of these men succeeded in struggling back to camp, where they found Mohi-ud-din dead alongside of his horse.

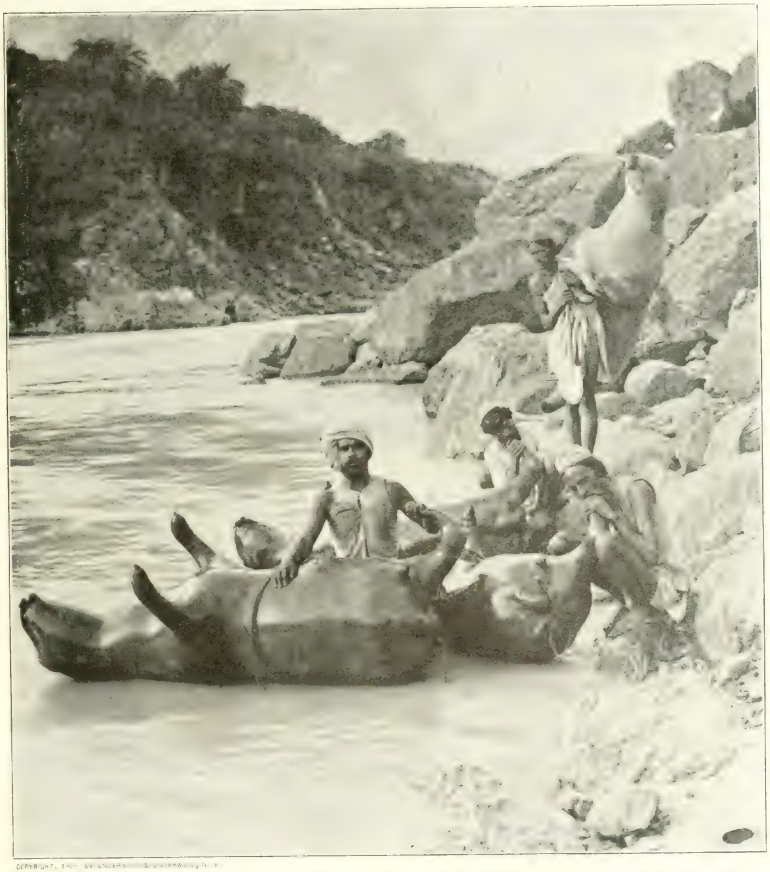
His faithful attendant, strong in his sense of duty, cut the map off the surveyor's plane table and wrapped it round his body in his waistband. He afterward explained that he was afraid to carry it in his hand, for fear he might become insensible and lose it. They then wandered from the camp, and, finally, all but Saidu lay down in the shade of a high mound to die. Saidu struggled on the whole day, but must have become delirious, for he remembered nothing till he regained consciousness for a time by stumbling into a pool of water.

On coming to again, he found himself being carried on a man's back to Chakansur. He had been discovered by some villagers, and, as in the case of the three guides, his life was saved only with great difficulty.

TYPE OF DESERT DWELLERS IN THEIR HOME.

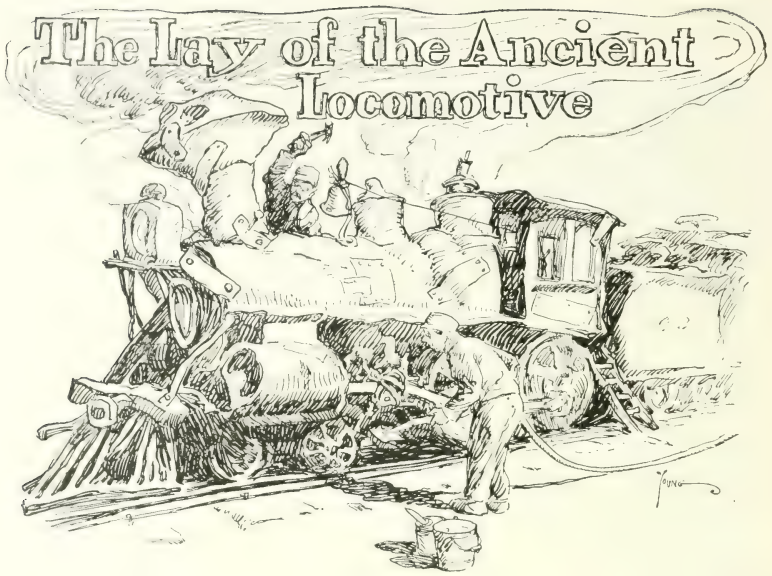
Dead Engineers are Buried

The Afghan authorities sent out search parties with water, and eventually recovered the bodies of Mohi-ud-din and the three sub-surveyors, together with the camp kit. The bodies were reverently interred by the Afghans at the shrine of Amiran, a place of peculiar sanctity, as Amiran is said to have been a first cousin of the Prophet. Mohi-ud-din's death, although brought on perhaps by a too venturesome disregard of danger, was a conspicuous instance of the devotion met with in the native ranks of the Indian Survey Department, and it is gratifying to learn that a fitting reward has been accorded to the faithful Saidu.



INFLATING BULLOCK-SKIN BOATS FOR CROSSING THE SWIFT KASH RIVER.

The Lay of the Ancient Locomotive



By R. B. Maulbert

THE engineer, a mighty man, with grease upon his nose,
Was crawling underneath his trucks and soiling up his clothes
To oil his throbbing engine, with a piece of rubber hose,
When sauntered up the fireman, a goodly man and true,
And spun this yarn which I, in turn, am spinning on to you.

"Twas many years ago," says he, a-pulling out a hunk
Of Brotherhood tobacco and biting off a chunk,
"When me and Bill, the engineer, first hiked it up the rails
With Bill behind the throttle of a bunch o' scrap and nails,
And me a-feeding paper waste and now and then a coal,
And all the while a-keeping of me finger on a hole
To keep the steam from spurting through, where she had sprung a leak,
And Bill so busy likewise that he couldn't stop to speak.

"Ah me, them times is over," and he heaved a heavy sigh,
And suddenly I noticed that a tear stood in his eye;

"We used to call her 'Grandma' 'cause she looked so weak and frail,
For every time she turned a wheel, she seemed to shed a nail;
Her firebox kept coming loose, her cab was all askew,
And every switch we hit she seemed to sort o' bend in two;
Sometimes she used to have a kind of fussy, fretful day,
And scattered every brand of junk along the right o' way,
The section bosses hollered that we littered up the track,
But used to save the pieces 'cause we had to put 'em back.

"But Bill"—his eye rove up the track—"was bound to stick it through;
He telegraphed in orders for manila rope and glue.

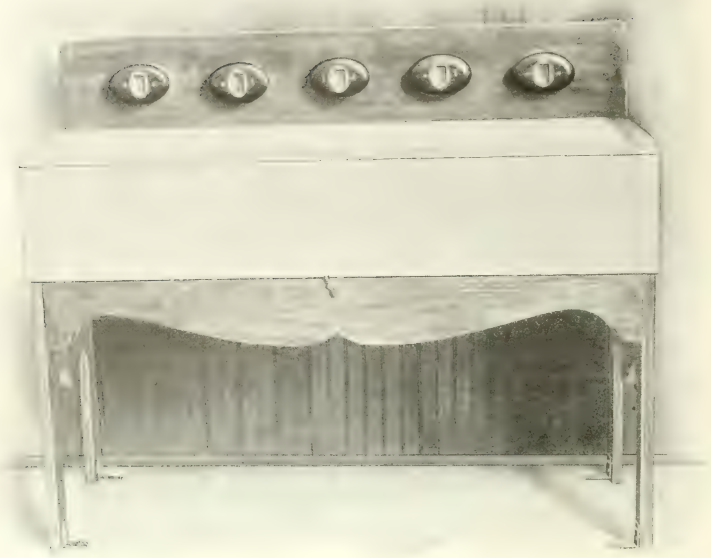
"One day we got dispatches for to shift an empty car
That was laying on a siding—and it wasn't very far—
But Bill got out his monkey-wrench and bolted on his clamps
While I patched up the biggest holes with canceled postage stamps;
We tied a rope around her and we nailed her smokestack fast
And Bill put in some mucilage and 'lowed he thought she'd last.
I heated up the water in her boiler to a boil;
We couldn't have it hotter 'cause she might blow up and spoil.

"Ah me, she was a gallant craft, that ancient iron steed."—
Dejection sat upon him as though his heart would bleed.

"She traveled down the rumbling road with weird, asthmatic groans;
She limped up to the box-car with her stiff, rheumatic bones;
We coupled on, Bill pulled her wide, she gave a mighty stir,
Her whistle blew, her bell rang out, she trembled to a blur;
Bill's face grew ashy pale; he cried, 'Jim, jump, she's going to bust;'
When suddenly she gently sighed, and crumbled into dust."

He stopped—the grimy engineer was crawling from his hole—
A minute more—the fireman was busy shovelling coal.

ELECTRICAL COOKING TABLE



Hail the Electric Housekeeper

Some of the Many Ways in which the Magic Current is Ready to Serve in the Average Home

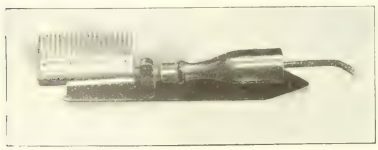
By E. S. WATERS

WOMAN'S Rights!

The right to vote at state and national elections; the right to hold all elective offices.

These be the subjects of shrill, vociferous demand, with the deep, basso-profundo growl of G. Cleveland leading the chorus in denial.

But there are other rights, vastly more potent, closer at hand, easier to get.



ELECTRICAL COMB.

And women seem strangely slow about taking them.—

The right to do that work which must always be the greatest work of women, in the easiest way; the right to all the assistance which science and invention stand ready to give.

Suppose a farmer still scratched the surface of his fields with a wooden plow, the riding sulky standing idle in the shed. Women and all, we should call him a fool, blind, behind the times, too much lacking in intelligence to be more than laughed at when he demands a wider voice in deciding matters of import.

Woman's Work is Never Done

It would be ungallant, certainly unpleasant, and possibly daugerous, to

make too clear the parallel between that farmer and the average housekeeper. Yet it is a fact that it is harder to introduce a labor-saving device in the kitchen than anywhere else. The successful manufacturer goes far afield to find anything which will cut down the labor necessary for the making of his product; but the head of the average private food factory sticks to her old ways and her old appliances with a devotion which goes far towards accounting for the truth of the old proverb that "woman's work is never done."

Not one woman in a hundred thousand has yet begun to realize that the best maid of all work on earth is the little copper wire which brings the electric current into her home for lighting purposes.

ELECTRICAL KITCHEN IN EDISON BUILDING, CHICAGO.

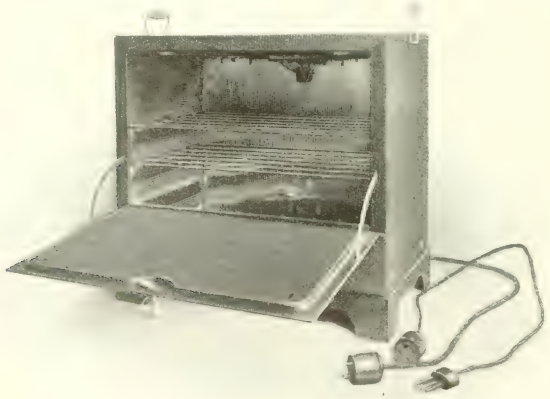
"We know all about it," goes up the answering chorus, "but it costs too much to run things by electricity."

The answer is not convincing, for the fact that not even in homes where the question of expense is not a vital one, has electricity been employed in one tenth of the ways in which it can do the work more quickly, more easily, and better than any of the agencies now in use. Furthermore, many electrical appliances could be used in the average family at an actual saving in dollars and cents, to say nothing of the saving in human energy and nervous force.

And the electric current—this should be a convincing argument with the neat and thrifty housekeeper — makes no muss; it does away altogether with smoke, soot, ashes, and dirt of all kinds.

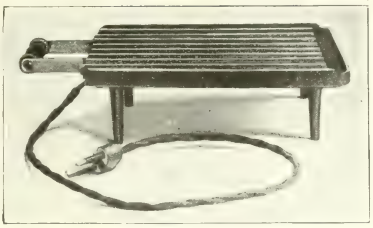
In the average kitchen, half or more of the heat is literally wasted—goes up the chimney. By the use of electric cooking apparatus one gets just the degree of heat required for just the time it is needed—and no longer. A one-hole electric cooking stove costs about $4 and can be run for half an hour for four cents. An electric flat-iron heater costs two cents to operate for fifteen minutes; a water heater costs five cents an hour; an electric waffle iron, five cents for half an hour; a chafing dish, perfectly cleanly, instantly ready, costs the same. There are also electric ovens, plate warmers, boilers, broilers, toasting irons, and all the other appliances which go to make up a complete kitchen.

ELECTRICAL STOVE AND KETTLE.



ELECTRICAL OVEN.

A newer application of electricity to household uses is the electric refrigerator. Heretofore the difficulty has been to make a practical apparatus small enough for use in the average household. An electric machine which



Electrical Broiler.

will furnish refrigeration equivalent to that supplied by 800 pounds of ice daily has been on the market for some time and shows a saving of fifty per cent over the ice-cooled apparatus. Now, it is claimed, a smaller electric refrigerator is about ready for general introduction, which will take the place of ice boxes which now use 100 pounds daily. It will show a considerable saving over the cost of ice, and will do away with the uncleanliness, odor, and general sloppiness which too often make the ordinary ice box a nuisance. The new machine will be so arranged that when the desired degree of cold is reached the electric current will be automatically shut off, to be turned on again in the same way when the temperature rises above a certain point.

Widely Used in France

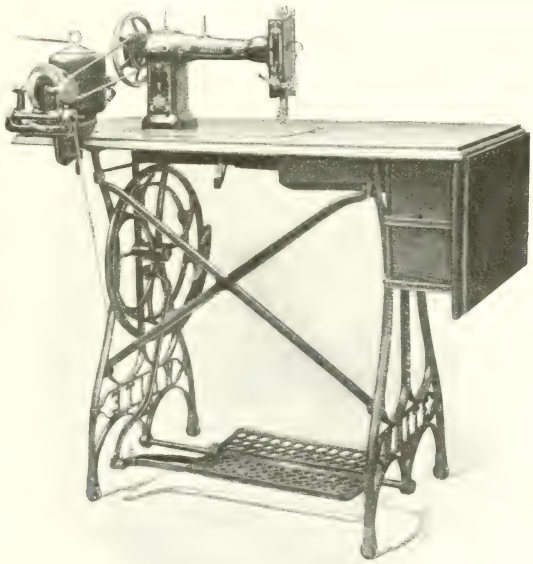
In France the use of electricity in the household kitchen has been developed more than elsewhere, though the kitchens of several of the larger and more modern hotels depend entirely for cooking purposes on the magic current. It has also been adopted by some of the ready-cooked food manufacturers and it shows them a substantial saving over other methods of obtaining heat.

As the development of water power and other large and low cost electric plants progresses, it is certain that the electric kitchen will come into more and more general use.

For the sick room and boudoir a number of electrical appliances have been put on the market which are a great improvement over anything heretofore devised. In the place of the familiar hot-water bag, for making local applications of heat, there is offered an electric heating pad, which not only does away with the possible danger of leakage, but retains its heat at any desired degree for as long as required. This pad costs one cent an hour to use.

To Heat the Baby's Bottle

Parents of young infants will appreciate a little device for heating the baby's milk. It can be turned on by the pressure of a button and does the work almost instantly. For invalids who suffer with cold feet there is an electric foot-warmer, which has all the virtues of other electric heating apparatus. And for keeping sick rooms at a continuously exact degree of heat, there are electric radiators, which, when properly man-



Sewing Machine Run by Electric Motor.

aged, do not greatly exceed in cost that of heaters using other fuel.

The woman who curls her hair may use an electric iron-heater at a cost of six-tenths of a cent for half an hour.

A small electric motor may be used in the household for running the sewing machine, and for a large variety of other purposes where a small amount of power is required, from playing the piano to rocking the baby's cradle.

Looked at from any standpoint the women of the world should be quite as vitally interested as are the men in the progress which is being constantly made in the production of cheaper power. Sooner or later, it is certain, the largest part of all household work will be done by electricity. Undoubtedly women may hasten the coming of that time by taking quick advantage of all the electrical aids which in great variety are even now ready for their service on an economical basis.

Damming a Southern River

The Great Lock and Dam on the Tennessee, which will Furnish Light and Power to the Historic City of Chattanooga

By ARTHUR B. HINSDELL

IN the valley of the historical Cumberland mountains thirty odd miles below Chattanooga, Tennessee, a lock and dam in some respects the greatest in the world is about to be built across the Tennessee river for the purpose of furnishing Chattanooga with light and power. The undertaking is to be an example of remarkable engineering work, and the power received will be equivalent to 36,000 horse-power. The lock is to have a lift of 40 feet, while the dam will be 1,200 feet long.

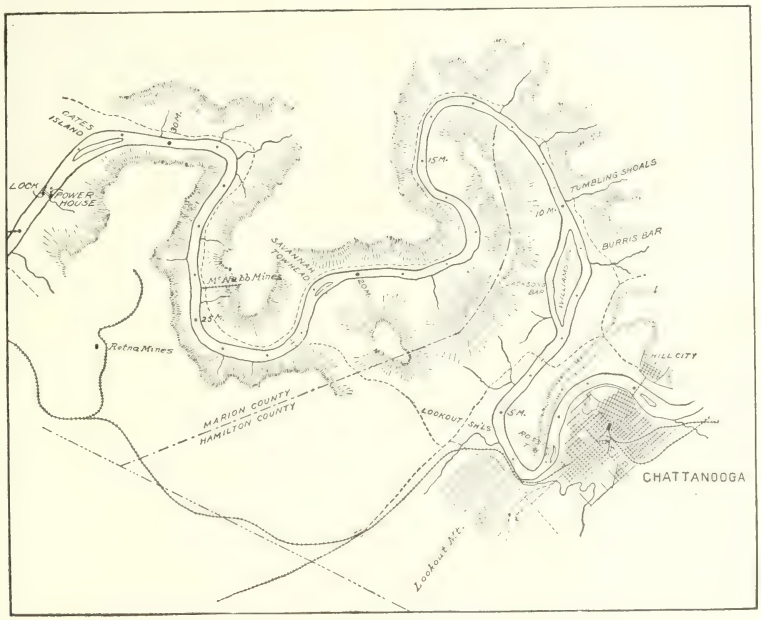
A corporation known as the Chattanooga & Tennessee River Power Company, of which J. M. Williams is the president, was recently incorporated for $3,000,000, and, after considerable lobbying, had a bill passed through Congress, under which they are to erect the lock and dam for the Government in return for the power privilege for ninety-nine years.

The undertaking seemed almost an impossible one; but Major Newcomer, Lieut. W. G. Capels, and John M. G. Watt, of the United States Engineer Corps, have solved the problem. J. C. Guild, a local engineer and an officer of the company, has worked out the power plans.

The site of the lock and dam is at Hale's Bar, a point thirty-three miles down the river from Chattanooga, but less than thirteen miles across country. It is at the exact spot where General Grant crossed with pontoon bridges in 1863. The original intention of the company and engineers was to locate the dam some fifteen miles farther upstream, at a place known as Scott's Point; but this was given up because of the steep hills on either side of the stream, affording no space for buildings. And then, too, this site would have been quite too close to the famous "suck" of the Tennessee river.

At the place now selected for the work, the river is 1,200 feet wide; and a cyclopean concrete dam with straight concrete facing will be built across at this point. The masonry work will be 50 feet thick and from 42 to 62 feet high. This height includes a 10-foot spillway, which will be raised and lowered by machinery. In the base of the construction

will be placed forty turbines, which will supply 37,500 horse-power—sufficient to light and heat as well as furnish motive power for all the manufactories and street-cars in the city of Chattanooga.

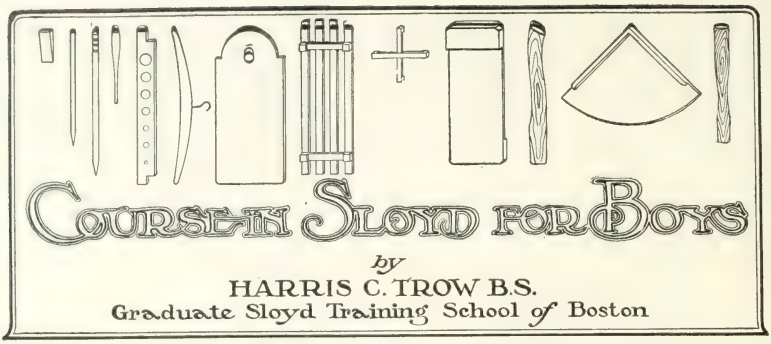


CHATTANOOGA LOCK AND DAM.

There will be enough left over to run trolley lines all over the State, should the promoters care to do so. The plant, next to those at Niagara Falls, will be the largest water-power plant in the country.

But the construction of the great lock is to be the most interesting feature of the work. A lift of 40 feet is designed, which means the greatest lock in the world. The lock will be located on the right-hand side of the stream opposite the power plant. The best of concrete will be used in the construction, and the inner walls will be 60 feet wide, 312 feet long, and 25 feet thick. The flood-gates of this lock will be under such a pressure as to require more than 50 horse-power to raise them.

The erection of the lock and dam in the Tennessee river will do away with the dangerous "suck" eighteen miles above, where hundreds of accidents have occurred to river craft. The Cumberland mountains come down with considerable steepness, crowding the stream into less than 900 feet of space, and causing the river at this point to flow at a terrible pace. Boats, getting caught in the suck, shoot through the pass at a speed which often results in accidents. This will be a thing of the past when the dam is completed, as the back throw will extend for twenty miles, causing the river to flow at a level of 630 feet above the sea for this distance. It descends through some forty feet along this course.



Course in Sloyd for Boys

by

HARRIS C. TROW B.S.
Graduate Sloyd Training School of Boston

Sloyd is the Swedish system of manual training, as originated and taught by Herr Otto Salomon of Nääs, Sweden. Sloyd differs from other systems of manual training in that it has for its object the harmonious development and training of head and hand. The course, of which this is the first lesson, is intended for boys of from twelve to eighteen years of age, and can be followed in the home, with the simplest tools. The course is just as valuable to the young man who intends to take up a professional career, as to him who proposes to follow a handicraft.—The Editors.

THE object of this series of articles will be to describe the construction of various useful objects, all of which can be made by anyone of a mechanical bent, if care be used in following instructions. The construction of these objects involves many of the fundamental operations of woodworking, which will be described in connection with their application to each model, so that anyone following the articles will not only have the satisfaction of making something useful and interesting, but will also obtain a knowledge of the correct method of using the common tools, such as the knife, plane, and saw, which every one should possess.

Model No. 1. *The Wedge.* The tools required in making this model, which is shown in Fig. 1, are a 3½-inch beveled-edge Sloyd knife, price 45 cents; a 2-foot 2-fold boxwood rule, price 15 cents; and a lead pencil, price 3 cents. The wood used should be well-seasoned white pine, with straight grain, of ½-inch thickness.

How to Make a Wedge

First split off a piece about 1¼ inches wide and 6 inches long. Instructions

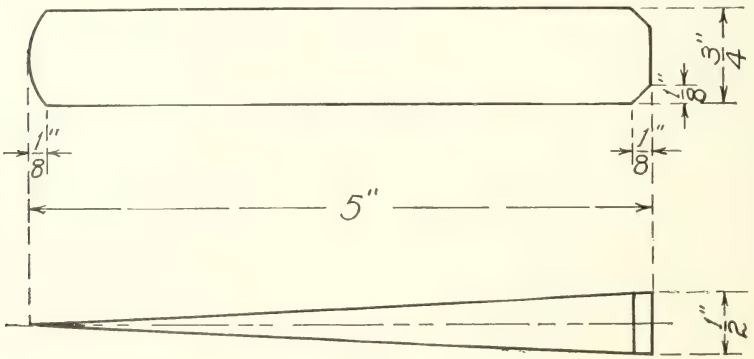


FIG. 1.

should be followed exactly here; and the wood should not be sawed, but split, in order that the grain shall be parallel with the edge. With the rule and pencil, rule a line on the broad surface of the stock, parallel with the edge and about one-eighth of an inch from it, so that when the piece is finished to this line all the unevenness left by the splitting cut will be removed, but without wasting any more stock than necessary.

The piece should now be finished to this line with the knife, which should be used with a drawing motion; that is, the knife should be drawn along from the heel to the point of the blade, at the same time it is pushed along the work. This enables the fine teeth, which are always present on any edged tool, to sever the fibers of the wood by a sort of sawing motion, which greatly facilitates the work, and permits of a better result being obtained.

The stock should be finished exactly to the line, and at the same time the narrow edge should be kept square with the broad surface. Always cut from the body rather than toward it.

Training for the Eye

In making this cut there will be a tendency for a right-handed person to cut under on the nearer left-hand corner and on the further right-hand corner, and special pains should be taken to avoid this. The trueness of the cut should be tested frequently with the eye, which will thus become trained gradually to detect the slightest inaccuracy.

Having finished this edge so that it is straight and square with the broad surface of the stock, lay off on the broad surface a distance of ¾ inch from the edge at each end, and connect these two points with a line, which will, of course, be parallel with the finished edge. Finish to this edge in the same manner as described in finishing to the first one.

Cut Towards the Center

Having done this, finish one end of the stock square and true with both the edges and the surfaces of the piece. In doing this the cut should be made from each side toward the center, because there is danger of chipping off parts of the object if the cut be made completely across it.

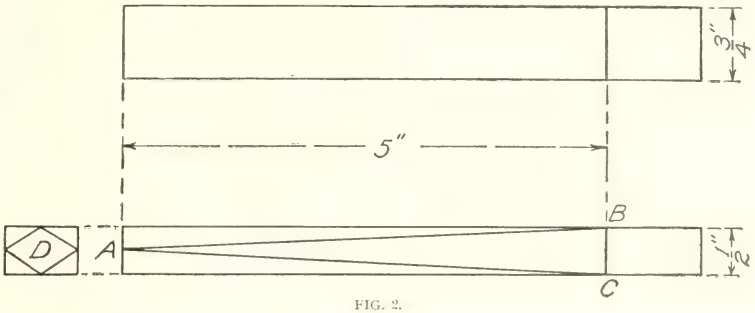


FIG. 2.

From this finished end lay off a distance of 5 inches, and rule lines around the piece parallel to the finished end, but do not cut off to finished length at present.

Turn the work on edge and rule lines AB and AC shown in Fig. 2, on both of the edges. In making the oblique cut which forms the taper of the wedge, do not attempt to bring the whole of the broad surface down to the oblique lines at once, but leave the center untouched, beveling down to the lines on either edge first, so as to leave the end view similar to D, Fig. 2. Finally finish the center also.

Knife the Only Tool Required

Next round the end as shown at the left in the upper view, Fig. 1, cutting from the edges toward the center or with the grain instead of against it.

This arc should be made by the eye, and care should be exercised to make

it a smooth curve or perfect arc of a circle. There is now nothing further to do before cutting off to length, which should be done by notching the work all around but well back from the finish line. After cutting off to approximately the correct length, finish to exact dimensions. Lastly, remove the corners as shown in Fig. 1, and the object is complete.

No other tools should be used in making this model than those described, as this is purely an exercise with the knife, and if performed according to directions will give a great deal of skill in its use.

Why the "Bennington" Blew Up

Disaster Caused by the Careless Act of a Fireman on the Ill-Fated Warship

By A. S. JOHNSON, Ph. D.

JUST as the weakest link is the "danger spot" in a chain, so the delicate gauges that have to bear the pressure of the boiler steam are the storm center for the eruptive forces of an engine room.

Other parts of the machinery may be weak through original defects in material or workmanship, or may be weakened as the inevitable result of the structural changes that accompany long-continued vibration, or may be damaged by accidental and unforeseeable mishap. All these dangers, however, may be classed as merely *occasional.*

CAPTAIN LUCIEN YOUNG OF THE "BENNINGTON."

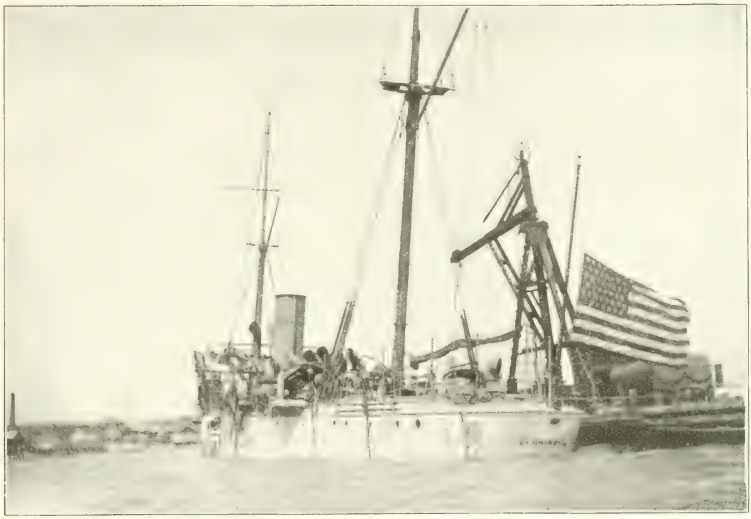
Gauges, the Danger Points

But here—in the little, thin glass tube that shows the height of water around the boiler tubes, or in the delicate piping and valves that connect the steam-pressure gauge with the steam drum, we have a *permanent* line of least resistance, necessitating constant care and vigilance to prevent disaster.

The full truth regarding the recent fatal explosion in the boiler-room of the gunboat *Bennington* (Capt. Lucien Young), as she lay in the harbor of San Diego, California, may never be known, for the voices that could probably have told the story are forever hushed; but the careful investigation that has just been concluded by a naval court of inquiry has elicited what the country will have to accept as at least a credible explanation.

What Caused the Explosion

It appears that for some unknown reason, one of the firemen had closed the valve in the pipe connecting the steam drum in the boiler with the pressure gauge. The boiler was thus left under fire, but without the possibility of any



THE U. S. S. *BENNINGTON* ON THE BEACH IN SAN DIEGO BAY AFTER HER BOILERS HAD EXPLODED.

indication of the pressure within—which may have been 100 or 200 or even greater. The natural result was a disastrous explosion, the boiler plates being ruptured at the moment their tensile strength was overcome by the increasing strain.

The ensign in charge of the boilers at the time is held responsible for the disaster. It was his duty to take personal note of the gauges, and see if they indicated the pressure in each boiler. In the case of a boiler that was being fired preparatory to putting to sea, the absence of any pressure record was a condition that ought to have excited suspicion at once.

Many another explosion has occurred through similar mischance; and cases have happened where the valve has been apparently open, but plugged with a deposit of sediment. The extremely regrettable incident at San Diego is but one more indication of the great delicacy of warships in spite of their strength, and shows the constant necessity for the exercise of the utmost skill and caution in caring for and operating these great mechanisms that are the basis of our sea-power.

American Foreign Commerce

Commanding Position of the United States in the World's Markets

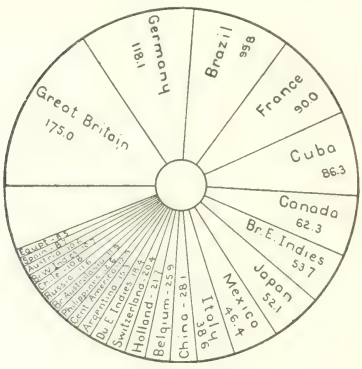
By SIDNEY JAMES

STATISTICS are ordinarily dry reading, but in some instances are not devoid of human interest. The accompanying diagrams, reproduced from *Commercial America* (Philadelphia), tell something of the titanic struggle of nations for supremacy in the world's markets.

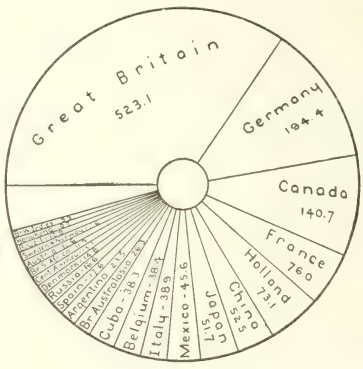
Over one-fifth of the entire foreign trade of the world is now in American hands. It is with Europe that we do the largest business, the contiguous countries of North America—Canada and Mexico

Largest Trade with Great Britain

Among individual countries, our chief trade is with Great Britain, which receives one-third of all our exports and sends us nearly one-sixth of our imports. Second in both imports and exports, stands Germany, which for many years has bought from us twice as much as it has sold us. That this condition of affairs is not wholly due to our tariff, as Germans claim, is evidenced by the fact that nearly three-fourths of our exports to Germany consist of products at pres-



Imports, $1,117,512,529.



Exports, $1,518,561,720.

FOREIGN COMMERCE OF THE UNITED STATES.

Figures for fiscal year ended June 30, 1905.—Values given in millions of dollars.

—standing next in line. Europe supplies almost one-half of what we buy, and takes more than two-thirds of what we sell. Among the continents, she ranks foremost in manufactures, and it is of these products of her industry that her exports chiefly consist; whereas our purchases from non-European countries comprise mainly food products and raw materials.

ent unobtainable elsewhere, raw cotton making up more than one-half the value, while almost everything we buy from Germany could either be made here at home or bought in some other foreign country.

In respect of balance of trade, Great Britain is even worse off than Germany, for last year its imports from the United States were nearly three times as much

as its exports to the United States. And other countries are in similar case, the Netherlands buying from us over three times as much as it sells us; Canada over twice, and Australia nearly twice as much.

Balances against the United States

In many instances, on the other hand, the balance of trade is against the United States. The Dutch East Indies last year sold to the United States more than ten times as much as it bought from it; Brazil, nine times; British East Indies, seven times; Cuba and the Philippines, each twice as much.

The enormous increase in the manufacturing interests of the United States in recent years, is shown in the fact that by far the greatest increase in our imports has been in materials for use in manufactures. While imports of food products and manufactured products have nearly doubled since 1870, imports of materials for use in manufactures have more than quadrupled in the same time, and have nearly doubled since 1895. Our total imports crossed the billion-dollar limit for the first time, in 1903; in 1905 they amounted to $1,117,500,000, of which nearly one-half consisted of materials for use in manufactures.

Sugar Bill the Biggest

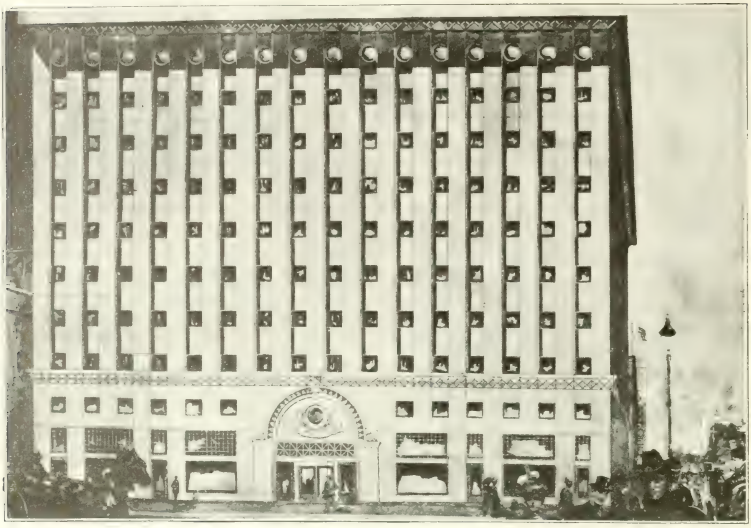
More money was paid in the United States last year for sugar than for any other single article ever imported during any one year. Our own territories are important producers, Hawaii supplying $35,000,000 worth, Porto Rico $12,000,000, and the Philippines $1,500,000—which, with the $97,000,000 worth from foreign countries, gives a grand total of about $146,000,000 as our sugar bill for 1905. The United States is the greatest sugar market in the world. Of the 6,000 million pounds of sugar annually consumed in this country, only about 1,000 million pounds is our own home product.

Coffee is, next to sugar, the largest item in the home expenses of Americans. In 1905 we imported 1,047,000,000 pounds, or nearly twice as much as in 1894. The price has fallen from about 16 to 8 cents a pound. Four pounds out of every five in the United States come from Brazil.

Rest

THE man who has money might rest if he would;
And the man who has none, he might rest if he could;
But never, till manhood has gone out of style,
Will the man who's a man want to rest all the while.

DES MOINES (IOWA) SAVINGS BANK HAVING GLASS-WALL CONSTRUCTION.



Modern American Glass Houses

A New Type of Building Construction that Combines Cheapness with Durability and Exceptional Cleanliness

By FRANK C. PERKINS

Consulting Electrical Engineer

THE Des Moines Savings Bank, as well as the Methodist Church in that beautiful city of Iowa, are to be built with glass walls, and a 26-story office building of glass has also been proposed. In structures built of this material, the ventilating, as well as the lighting, heating, and cleanliness, excel, it is claimed, anything of this character ever before attempted.

These buildings were designed by C. E. Eastman, a well-known architect of Des Moines, Iowa, whose idea of glass-wall construction includes the use of milk-white, opalescent wire glass ¼ inch thick, securely fixed in two steel vertical divisions, which are parallel and laced together for the purpose of stiffening. These divisions are supported at the floors by brackets riveted to the steel channels of the floor construction. The wall thus consists of two glazed screens separated by a foot of dead air space, which affords insulation against heat, cold, or sound to as great an extent as would a solid brick wall of the same thickness. The double vertical divisions are spaced about four feet apart. The two glass screens are translucent to any degree desired, so that, in cases where windows are not necessary for viewing the landscape, they may be dispensed with altogether, provided the building would warrant the installation of mechanical ventilation and heating. The exterior effect is that of a marble wall with or without windows. If windows are desired, it is not necessary to have the regulation two-sash type; but, as the pockets are already provided, single-sash metal windows can be used, lifting up into a metal guide, into the space of the

wall. Onyx and many other kinds of stone can be imitated with the glass.

The construction provides approximately an inch for movement at the edges of the glass sheets, which are about 4 feet by 10 feet in size. This will cause any uneven settlement of the building to be adjusted by itself in the framework and glass, without becoming evident to the eye.

A glass wall is of very light weight compared with one of masonry. Fire damage would be local and easily repaired, experience showing that the wire glass prevents the spread of fire, though the glass itself is shattered. With this construction, however, replacing material is easier than would be the reglazing of a window of the same size. The expense of a glass wall is some less than that of a brick wall, and lacks all the disadvantages of the latter, being much lighter in weight, allowing a soft light to penetrate through, and having a surface which is self-cleaning in wet weather, and which, in the case of tall buildings in cities, reflects light to the lower portions at the sidewalk.

The fact that no windows are necessarily required is one of the chief advantages claimed for this method of construction, since the entrance of dust, smoke, insects, etc., through such openings, is rendered impossible. When an outlook is desired, however, plate-glass windows can be inserted.

Calculating Indicator Cards*

Describing the Method of Finding the Area, and from it the Average Height of an Indicator Card, both by Actual Measurement and by the Planimeter

By CARL S. DOW, S. B.

THE mean effective pressure, or M. E. P., of the steam in the cylinder of an engine, is equal to the area of the indicator diagram divided by its length. The length is easily found by measurement but to find the area is more difficult since the shape is irregular. If the figure were regular its area could be found by geometry or by simple formulas.

The area of the indicator card can be found in two ways—by dividing the diagram into sections and by the use of a planimeter. The former is only an approximate method; the area thus found is nearly correct if the number of divisions is great.

Division into Sections

Tangents at each end, perpendicular to the atmospheric line, are first drawn. The horizontal distance between these tangents is then divided into 10 or more equal parts. The horizontal length of each section is then divided into two

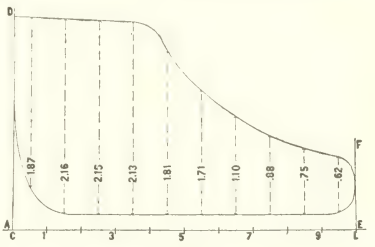


FIG. 1.

equal parts, and lines perpendicular to the atmospheric line drawn through these points of division. The sum of the lengths of all these lines is divided by the number of lines to get the average. This average length or average ordinate,

*From the Author's Instruction Paper on Steam Engine Indicators. Written for the American School of Correspondence, at Armour Institute of Technology.

multiplied by the scale of spring, gives the mean effective pressure.

Fig. 1 is the card from the crank end of an engine. The line C L is the atmospheric line and the lines A D and

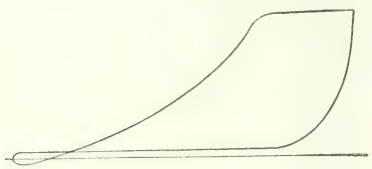


Fig. 2.

E F are drawn perpendicular to it and tangent to the extreme ends of the diagram. The line A E is divided into 10 equal parts, and lines are drawn through points marking the centers of the divisions. On each of these lines the length is marked. The sum of the lengths is 15.18, and 15.18 divided by 10 is 1.518. If the scale of spring is 40 pounds, 1.518 multiplied by 40 is the M. E. P., or 60.7 = M. E. P.

The horizontal length may be divided into any number of equal parts; but 10 or 20 makes the computation easy. The operation of finding the M. E. P. for the head end is exactly the same. The average M. E. P. for one revolution of the engine is the average of the two mean effective pressures.

In case the diagram is very irregular it should be divided into 20 equal parts instead of 10. If there is a loop in the diagram as shown in Fig. 2, the area of the loop must be subtracted from the area of the other part, as it represents work done by the piston on the steam and therefore loss.

The lengths may be marked off on a piece of paper if a good scale is not at hand.

Planimeter Method

A more accurate result is obtained by using an instrument called the "planimeter." There are several planimeters and averaging instruments in common use for determining the mean effective pressure of indicator cards. The planimeter shown in Fig. 3 is one of the most simple, and is called the Amsler Polar Planimeter, from its inventor, Prof. Amsler. The cut is about one-half the size of the instrument. It consists of two arms free to move about a pivot, and a roller graduated in inches and tenths of inches. A vernier is placed with the roller so the areas may be read in hundredths of a square inch. The point A is kept stationary, and the tracer B is moved once around the outline of the diagram. The area in square inches of the diagram is read from the roller C and the vernier E.

To Use the Planimeter

The diagram should be fastened to some flat, unglazed surface, such as a drawing board, by means of thumb tacks, springs, or pins. The point A is pressed into the paper so that it will hold in place. The point B is set at any point in the outline of the diagram and the roller set at zero. Follow the outline of the diagram carefully in the direction of the hands of a watch as indicated by the arrows in Fig. 3, until the tracer has moved completely around the diagram. The result is then read to hundredths of an inch from the roller. Suppose, after tracing over the outline, we find the larg-

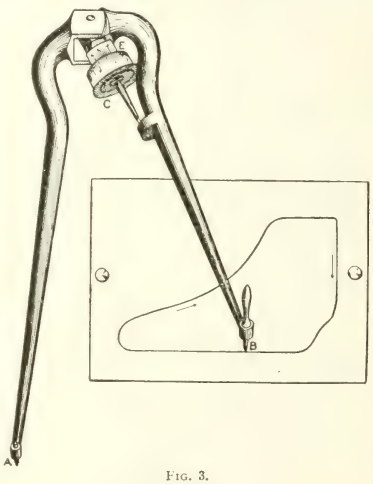


Fig. 3.

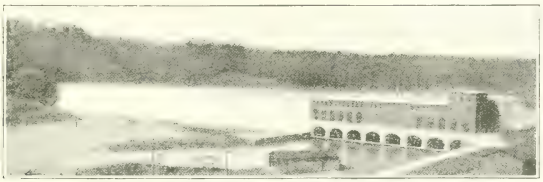
est figure that has passed the zero of the vernier to be 3; the number of graduations (tenths) that have passed the zero to be 5; and the number (hundredths) of the graduations in the roller that exactly

coincide with the graduations on the vernier to be 9. Then the area is 3.59 square inches.

Often at the start the roller is not adjusted so that the zeros coincide, but the reading is taken and subtracted from the final reading. Thus if the first reading is 4.63 and the second 7.31, the area is 7.31 — 4.63 = 2.68 square inches. In case the second reading is less than the first, add 10 to the second reading, then subtract.

This instrument is very valuable to an engineer who takes indicator cards. The results obtained are very accurate, the error being small. Ten or twelve diagrams can be measured by this instrument in the same time that is necessary to measure a single card by the method of ordinates.

It is well to run over the area three or four times and take an average, as the tracing of the diagram cannot be absolutely correct at any time.



Ough

THE ploughboy whistled behind his plough,
For his lungs were sound and he had no cough;
He guided his team with a pliant bough,
And watered it well in a wayside trough.
The toil was hard for the land was rough—
It lay on the shores of an Irish lough—
But his well-fed team was stout and tough,
And he plied his bough to flank and hough.
He toiled all day, and the crow and chough
Flew round his head, though he oft cried "Shough!"
But his plough at eve struck a hidden slough
With a force that sent the share clean through;
The frightened team ran off with the plough,
With the speed of the wind from the ploughboy, though
He shouted "Whoa!"and into the slough
It plunged where the mud was soft as dough.
The ploughboy wept—for the wreck was thorough—
He fled that night from the farm to the borough.

Some Things We Think

¶ It is easier to get into public life than to stay there

¶ Few things are more precious than well-won praise.

¶ After all, when it rains, it settles the dust; and when the sun shines, it dries up the mud.

Power and Progress

THE material progress of the world hinges on the cost of power.

A laborer, turning a crank and receiving a wage of seventy cents the day, produces one horse-power-hour for eighty-five cents.

An ox, turning a horizontal bar—a method of power production still employed in eastern countries—cuts the price to twenty-three cents the horse-power-hour. A horse in place of the ox makes a further reduction to a fraction less than twenty cents.

A steam engine, even when used carelessly and inefficiently, produces a horse-power-hour for four cents—mark how magnificently material civilization has responded to the stimulus!

A gas engine produces power more cheaply than steam; a windmill, when it works, furnishes a horse-power-hour at a cost of 2 cents, but cannot be depended on.

Now, at the climax, M. Charvet, the French engineer, who has made the experiments and calculations on which these comparative statements are made, announces that, where the installation does not cost more than $160 a horse-power, water power will produce the unit of work at a cost of one cent.

All over the world engineers are developing long-neglected waterfalls and rapids; and every little community in the vicinity of which such a rapid running stream is found, may count itself vastly more fortunate than if gold or diamonds had been discovered within its borders.

Cheap power means rapid progress.

¶ "We cannot help anybody farther up than we stand ourselves."

¶ Anticipating to-morrow and regretting yesterday is the way some men divide their time.

¶ Experience is the best teacher; but sometimes—particularly in matters feminine—a fellow has to pay a pretty high price for his diploma.

Steel Railroad Cars

THE use of steel for the construction of railroad cars has advanced rapidly within the last few years; and for certain kinds of service—such as in tunnels and on elevated structures—the all-steel car is now generally recognized as the common standard. Whether steel will eventually take the place of wood for surface railways, yet remains to be seen; but it offers some very distinct advantages which cannot be lightly dismissed. The causes leading to the adoption of this style of car were probably tunnel accidents, which have in many cases resulted in disastrous fires in which wooden cars have been consumed. Many deaths have occurred from burning and smoke, which would have been avoided had the cars been built of incombustible material.

The first step in the construction was to make the sills and underframing of cars, of steel, upon which a wooden superstructure was raised; but the all-steel car soon followed, and, in addition to its fireproof qualities, it is probably more durable and stronger than the wooden car. Another advantage which can be

credited to the steel car is that it can be built lighter than the wooden car, and consequently there is less dead weight per passenger to be carried—which results in a corresponding diminution of the motive power required.

¶ If you have found fault unfairly, at once seek to make proper amends.

Electric Railway Progress

A FEW months ago the single-phase alternating-current system for street-railway propulsion was in an experimental stage; and in the TECHNICAL WORLD MAGAZINE for April, 1905, appeared a description of the newly completed system of the Indianapolis & Cincinnati Traction Company, which was the first road to be equipped with the single-phase alternating-current system. Although this system has been in commercial operation only since last March, announcement has just been made that the New York, New Haven & Hartford Railroad has adopted it for the suburban portion of its line running into New York City.

This railroad enters New York City over the tracks of the New York Central; and it will be remembered that the latter road is changing over to electrical propulsion for some distance out of New York City. A description of the electric locomotives to be used by the latter road was also published in a recent number of the TECHNICAL WORLD MAGAZINE.

The great flexibility of the new system which is being adopted by the New York, New Haven & Hartford system is shown in the fact that while the New York Central operates upon the direct-current system, the alternating-current system to be adopted is capable of operating upon either a direct or an alternating current; and over the electrical portion of the road the New York, New Haven & Hartford cars will first operate by the direct current, and then by single-phase alternating current, without any change or duplication of the electrical equipment on the cars.

This makes the fourth large railroad to adopt electricity as its motive power for the suburban parts of its route. Besides the two roads just mentioned, the Baltimore & Ohio Railroad operates its trains in Baltimore electrically, and the Pennsylvania Railroad will soon operate its New York terminus in this way. It appears, therefore, that the day is approaching when the steam roads as well as the street railways will come to electrical operation; and the engineering world will soon have an opportunity of judging the comparative merits of the direct- and the alternating-current systems under heavy railroad service.

¶ If a thousand plans fail, be not disheartened. As long as your purposes are right, *you* have not failed.

The Declining Birth-Rate

IT is easy enough to prove anything by statistics. Just leave out the pertinent figures, and the trick is done. A thousand births in a city of a certain size, and a thousand deaths during the same period, would seem to indicate that the population of that city was at a standstill; but such is not necessarily the case. Towns have been known to spring up like mushrooms, without a single birth; and, similarly, once populous sites have been deserted without imputing to their inhabitants the slightest suspicion of an addiction to race suicide. A yearly birth-rate of 10 in 1,000, where those ten are raised to the stature of full-grown and efficient manhood and womanhood, counts more than a birth-rate of 100 in a fever-infested slum district. Just as it is not so much what we earn as what we save, that makes us prosperous, so it is not so much the number of children born as the number raised and educated that counts; and the conclusions drawn from birth statistics will always be fallacious until based on all the pertinent facts.

Should the genius for making foolish appropriations go the length of offering a $2 premium for each birth reported, the experience gained in school census taking at so much a head would quickly demonstrate anew the flexibility of figures "that never lie."

Dog Police on Guard

Marvelous Work of Regular Four-footed Members of the Force in Ghent, Belgium

By WILLIAM G. FITZGERALD

Author of "Around the World," etc.

THE quaint old city of Ghent, Belgium, is probably the only place in the world where dogs are regular members of the police force, have uniforms of their own, servants to wait on them, and a kitchen of their own, where their rations are cooked and served.

It is well known that dogs have been used with great success in the French and German armies, where they are not only employed as scouts, especially at night when a surprise attack is possible; but are also employed with the Red Cross Ambulances and to carry medicines and restoratives onto the field of battle.

Then, again, we find especially intelligent dog-smugglers in Gibraltar, going to and fro across what are known as the "neutral lines"—a narrow "no man's land," between the frontier of that famous British fortress in the extreme south of Spain, and Spanish territory proper.

Advantages of Dog Police

It was several years ago that the Chief of Police in Ghent pointed out that a cleverly trained dog could run down a pickpocket more surely and quickly than any two-legged policeman. Moreover, in the case of a desperate burglar lurking in a dark store or warehouse with ready revolver, it would manifestly be better to risk the dog's life at first rather than that of an officer. In any case the dog policeman could hunt up and disturb the lurking marauder, exactly as a dog would do when hunting game.

THE DOG POLICEMEN'S DINNER HOUR.

The idea found much favor with the municipality, and the Police Chief was permitted to get his dogs—a matter which occasioned him no trouble whatever—since the dog in Belgium works to an extent absolutely unknown in this country.

For example, in big Belgian cities like Brussels, Ostend, and Liège, one will see dogs either singly, or two or three abreast, hauling small specially-made carts containing laundry linen, milk, green-groceries, bread, and other articles, such as are delivered by man-pushed carts or wagons in other countries.

Dog Costs More Than Donkey

In Belgium, oddly enough, a first-rate draught dog may cost as much as a donkey, or even more—say $20. I asked the reason for this, when it was pointed out to me that, firstly, the dog would travel faster than the donkey; secondly, no stable was needed for him; thirdly, he would cost less to feed; and fourthly, when his day's work was done he might be trusted to go out and bring home the cows—which last-named duty could, of course, be expected of no ordinary donkey!

When the Chief of Police had secured his pack of "recruits," he began to train them to distinguish between skulk-

ing criminals and the ordinary, reputable citizen, who walks by day. Some very interesting demonstrations and experiments were tried by means of dummies; and it is a fact that in a few weeks the more intelligent dogs had learned how to spring upon and take hold of a man by his clothes without driving their teeth into him.

How the Dogs are Cared For

Special kennels were then built in the police stations, with the name of its occupant over the door of each. Coats, collars, and muzzles were provided by way of "uniform," and there were even little boots provided for snowy weather. A veterinary surgeon was appointed at police headquarters to care for the dog policemen when they were sick, and the matron at each station was charged with the duty of getting their meals ready when each dog came off duty with his two-legged fellow officer. The dogs are particularly useful to the police at night, and save them an enormous amount of running backwards and forwards.

Pickpockets and snatch-thieves in the city of Ghent, if they have not altogether disappeared, bid fair to do so, for these criminals know that no matter how fleet of foot they may be, the police dog is still swifter; and no matter how they may try to turn and dodge down one street and up another, the dog is not only with them, but his sharp fangs are tearing through their clothing before they have gone many yards. If they show fight, so much the worse for them, since even the most correct and best-behaved dog policeman is apt to forget the strict letter of his duty when cuffed by a criminal.

Bring Home Lost Children

These dogs will also bring home lost children, and are so highly intelligent that they will absolutely refuse food from strangers. Accordingly they are seldom or never drugged or poisoned by persons interested in getting rid of them.

POLICEMAN OF THE CITY OF GHENT GOING ON DUTY WITH HIS FOUR-LEGGED MATE.

The details of their sagacity indeed are almost incredible. Some of the Ghent people think the police dogs altogether too officious. Certain it is they are most anxious to get a "case," and will look askance and follow a person of suspicious appearance, even though he may be perfectly harmless.

Under these circumstances, it is no wonder that the people and police of the city of Ghent should be proud of their dogs. They are everywhere petted and made much of, and seem to realize by instinct who is or is not a respectable person. Altogether so successful has been their record, and so economical and efficient are they found, that other municipalities are very seriously considering following the example of Ghent in the use of "dog policemen."

Use of Small Motors

Individual Motors for Printing Presses and Other Machinery

By ARTHUR B. WEEKS

BECAUSE of its unquestioned superiority over any other method of driving, the individual motor is coming more and more into favor, the 220-volt direct-current motor being probably the one most used in this connection. The machinery is of special design, so constructed and located that the motor is out of the way of the operator; it is usually of the enclosed type, easily controlled and seldom out of order. This is one of the great advantages of the modern direct-current motor over those of the older styles—they do not cause the trouble inherent in almost any of the direct-current motors of several years since. Nor is there anything complicated about the starting devices; for, while it is a good thing for an operator to know something about the apparatus other than the method of starting and stopping, it is not essential, for an electrician is always to be had at a few moments' notice, should his services be required.

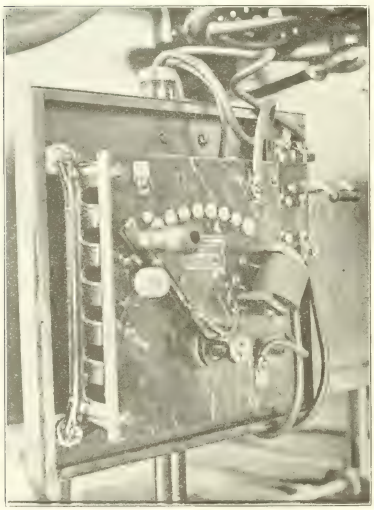


FIG. 1.

Method of Controlling

In Fig. 1 is shown the starting device for a printing press for one speed only. It is conveniently located at the front of

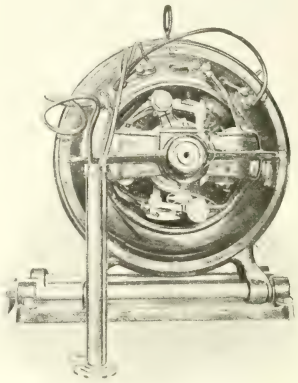


FIG. 2.

and below the press, easily accessible for starting and stopping, yet not at all in the way. The switch is first closed, then the rheostat lever turned slowly to the right to the last notch. This style is not intended for running on intermediate points, but should be put on gradually from the first to the last point. If a fuse blows while the machine is running, or if from any cause whatever the circuit is opened, the lever will return of itself to the starting point. The small coil of wire at the right is an electro-magnet, and as long as the lever is on full and the current on, the magnetism will retain the lever. This is styled a "no-voltage release" rheostat. The fused switch is seen open at the right of the rheostat.

Should it be desired to know something of the wires and method employed, an iron conduit will be seen extending up through the floor, and containing the wires for the rheostat. The remaining

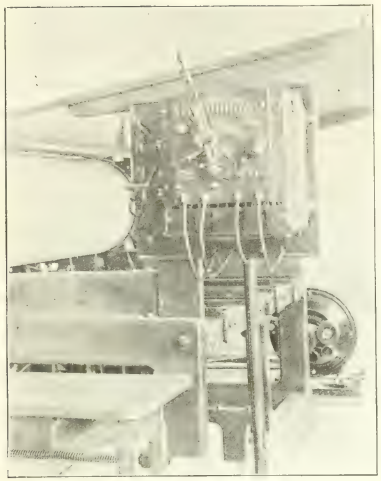


FIG. 3.

wires extend upward through a similar conduit shown in Fig. 2, which gives an end view of the motor for this press. This conduit insures neatness and safety, and offers protection to the wires.

Motors are connected in this way to Miehle, Gordon, and other makes of presses, as well as paper-cutting machines and book stitchers. Wiring from beneath the floor makes a far neater job than any other method, all wires being concealed and safe from injury. It is necessary to prepare a suitable board on which to place the rheostat; this is a plain piece of wood covered with asbestos and painted with black insulating paint, with the moulding applied around the outside, as shown. An ordinary pipe cleat can be used at top and bottom to secure the board to the conduit, passing stove bolts through both. Place porcelain insulators at the corners of the rheostat, and secure the latter by stove bolts through both.

Variable Speed Control

Fig. 3 shows a rheostat and motor for a large press requiring several speeds, the compound controller permitting this variation. This controller is made to run on any points desired to obtain the required speed. The motor has an idler to give tension on the belt, though this can be accomplished in several ways. The controller is within convenient reach of the operator. The motor for this press is 4 H. P.

The motor shown in Fig. 4 is for the purpose of driving a small line shaft for several small machines. There are several posts in line, like the one shown, each having a box for the shafting. The machines are belted from pulleys on this line shaft to one on the machine, having a tight and loose pulley. This means a considerable saving over some methods, since one motor can thus do the work of several smaller ones. The conduit is shown at the corner of the post, a short one for the motor and a longer one for the switch and starting rheostat. There is a shaft hanger on this post, and a pulley in line with that on the motor. There is also the customary means of adjustment to maintain tension of the belt. The machine shown is a paper cutter. Each floor should have a panel-board for controlling the circuits of the motors on that

FIG. 4.

floor. There should also be lighting panels for each. Each circuit, both for motors (220-volt) and lights (110-volt) is fused, and each has also a switch.

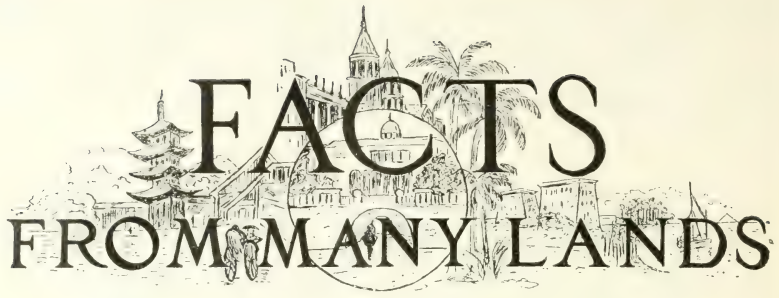
BIRTHPLACES OF

Birthplace of Rufus Choate, situated on Choate's Island, Mass. Built in 1625. It was the ancestral home of Joseph Choate, late Ambassador to Great Britain. Rufus Choate was a most distinguished lawyer, orator, wit, and statesman. In 1841 he succeeded Daniel Webster in the United States Senate. At the bar and in politics he was Webster's greatest rival. He died in Halifax, Nova Scotia, in 1859, at the age of sixty. The old house has been standing for nearly 300 years, and, in spite of its exposed position, is still in a good state of preservation.

Birthplace of Count Rumford, Woburn, Mass., the earliest scientific philanthropist. He designed public gardens. He proved that heat is motion and had a glimpse of the great doctrine known later as the Conservation of Energy.

Birthplace of John G. Whittier, the Quaker Poet, at Haverhill, Mass. Whittier was one of the leading anti-slavery agitators of ante-bellum times. More than once he was attacked by mobs, because of his openly expressed opinions. He served one term in the Massachusetts Legislature.

Birthplace of the philanthropist, George Peabody. Situated on Washington Street in Peabody, Mass. Peabody settled in London as a banker in 1837. Among his benefactions are the Peabody Institute in Baltimore, a fund for education in the South, and many gifts to colleges.



IT requires a pressure of 155 tons to stamp a United States gold double eagle. To stamp a nickel five-cent piece requires 60 tons pressure, and a copper cent requires 40 tons.

* * *

China has only 5,000 miles of railway as compared with more than 200,000 miles in the United States. At the same time it has a population of 400,000,000, six times as large as that of the United States. There is plenty of work for railroad engineers and contractors in the Celestial Kingdom.

* * *

Dr. Max Reithoffer, professor at the Vienna Technical High School, who is considered an authority on the wave theory, has, jointly with the court watchmaker, Karl Morawetz, submitted to the common council of that city a plan for an electric system of clocks run by wireless electricity. They propose to furnish the chronometric and electric apparatus, including clocks, to the city free of charge, and to make the trials. The city has only to furnish the current and the cable connections and give the use of suitable buildings. The common council has appropriated $600 for making experiments. If these should lead to the adoption of the project, Vienna would be the first city in the world having a system of electric clocks regulated by wireless connection.

* * *

The Prussian Ministry of Railways has placed at every important railway center throughout the kingdom a magnificently built and appointed car for the transport of sick persons. These cars have been specially fitted up from plans supplied by sanitary authorities. Spring beds and every medical device for the alleviation of suffering during transit have been utilized. There are ice safes, gas stoves for cooking, rooms for attendants, and ingenious devices for muffling the sound caused by the motion of the train. It is not intended to make these carriages pay; they have been instituted chiefly on the ground of humanity.

* * *

Over 10,000 human beings were killed last year on the railroads of the United States, according to the reports of the Interstate Commerce Commission. No less than 84,155 were injured during the same time.

* * *

Work on the electric road to the top of Mt. Blanc has commenced. An altitude of nearly two and one-half miles is reached at the terminus. The track is laid on metal ties, and the road will be twenty miles long. Trains will run from bottom to top in four hours, stopping at each station to allow passengers to view the scenery and grow accustomed to the rarefied air. A train will consist of an electric locomotive and two trailers, seating a total of eighty passengers. The line will be completed in 1911.

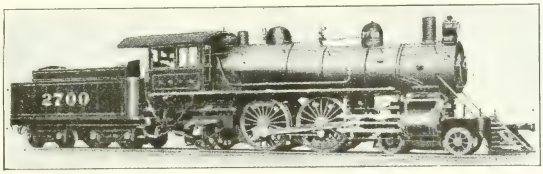
* * *

It is claimed that car wheels made from rye straw paper have run 300,000 miles and then been found still good enough to be equipped with a new set of steel rims so that they could go on another similar little trip.

* * *

The Dominion Coal Company (Glace Bay, Nova Scotia) is testing a machine

intended to take the place of explosives. It is a hydraulic cartridge, said to be successful in Great Britain. At present coal is blown down with powder after the undercutting is completed. In the use of the cartridge, after the undercutting and shearing are finished, a hole 3½ inches in diameter is bored in the coal parallel with the roof, wherein the cartridge is inserted. A piston operates at one end and a pump at the other. The pump forces the water along a tube until it comes in contact with the first piston and pushes it out. The pressure becomes general on all pistons, which commence to penetrate the coal in a downward direction. The pistons are set very close, there being scarcely half an inch between them. As the pressure increases the coal gradually leaves the roof and falls to the floor in the best salable condition. When powder is used in blowing down coal, there is considerable waste through breakage into dust and slack. It is claimed that this element of waste is greatly eliminated by the use of the cartridge, and 40 per cent more salable coal is produced than by the ordinary methods of mining. The weight of the entire apparatus is 44 pounds. One man can operate it. The amount of water required is from a pint to a quart, according to the pressure needed to bring down the coal. The water is stored in a little reservoir attached to a pipe, and runs to the bottom of the pump. The machine is supposed to be especially serviceable in long wall and pillar work.



The Great Men Pass

THE great men pass. We stand appalled, and say,
"How shall we live, when these have left our day?
How shall we fight, when splendid leaders fall?
How work, when silent is their bugle-call?"

Ah, friends, the great men pass, but greatness lives!
Strength for the work the Master Workman gives.
From heaven's high wall of jasper, true and clear,
Rings out the clarion call; we need not fear.

God's battles do not cease—still in the van
The Captain's banner flies; the Son of Man,
True Son of God, and deathless, leads the way;
To-morrow shall make up for yesterday.

The great men pass, but pass into the light,
Their brave feet climbing up some heavenly height.
We need not fear, or great or small, if we
Are workers for the vast eternity.

—MARGARET E. SANGSTER, in *Everywhere.*

"A great column of water which rose through the vapor and flame."

The Fight of the "Nixon II"

Being an Incident of the Second Russo-Japanese War

By WILLIAM R. STEWART

WE were not a fighting crew, orthodoxly speaking. Sam Miller, the captain, was the only one of us who had seen service. He had been a midshipman on the *Adder,* in 1898, when it captured a British schooner trying to sneak into Havana harbor. Bill Jones, the first lieutenant, came next nearest to having seen a fight. He was shot at by a Canadian revenue cutter when poaching on Lake Erie. The rest of us, outside the engine men and the stokers, were where we were because we had worked on the boat for the man who built her.

"It's going to take a blamed sight more luck than we're likely to get to take us to Vladivostok without a fight," said Miller, sweeping the horizon with his telescope and noting an uncomfortable number of Japanese ships. Responsibility must have been weighing on him, we thought, for a fight was just the thing we knew he wanted.

Looking for Luck

"Luck! I sh'd say 'twould be mighty poor luck if we did," retorted Jones, and "That's right," from Clarke, who had charge of the deck gun, emphasized the disagreement.

"Well, well, we'll get the luck you want, certain enough," said the captain. "'Twouldn't be so bad at that if I knew you fellows wouldn't fumble somewhere at the wrong time." It was a way with Miller to make light of our fighting worth because we had not been put to the test and he had.

"Leave us alone for that," we assured him, and he smiled good naturedly. He knew every man of us was true, and was only bantering when pretending to doubt.

The southern coast of Sakhalin loomed mistily in the morning sunlight as we skirted it on our course. With only our armored top and observation tower showing above water, we had little to fear from the eyes of the Japanese. Nearer to Vladivostok we would not have minded the eyes; but off Sakhalin, with no Russian warship within 100 miles, and the Japanese wirelessing all about us, we were not taking chances.

Fleet of the Czar Unprepared

As at Port Arthur six years before, now again the fleet of the Czar had been caught unprepared. The clashes in Sakhalin, invited by the Treaty of Portsmouth, had not been treated at St. Petersburg with the importance which they merited. The bureaucracy, busy with new plans in Persia and with eyes once more on Constantinople, had been blind to the rapid development of the crisis.

Only a half-dozen cruisers, built since 1905, a score or less of torpedo-boats, and three of the new and untried type of craft, of which we were one, made up the Russian naval force in the Pacific. Dwarfing this into seeming insignificance were the battleships of Japan and Great Britain, united still by treaty, and ready to crush Russia as she never had been crushed before.

An American Submarine

Yet, as the whitish-green waves broke easily over our deck on that April morning, there was not a man of us who did not believe that a new wonder was about to be revealed. Within the 275 feet of length and 32 feet of our breadth, we had instruments of destruction such as never before in history had been tried on an enemy. It might be a breach of neutrality to fight, but the fight was not of our choosing. We had engaged as crew because an American inventor had hired us, and the Russian Admiralty was experimenting with his invention. Besides, the dominance of the Anglo-Japanese alliance, and some disputes over the Philippines, had changed American sentiment since six years before.

Below Sakhalin the sea stretched a wide arm inland, and far on our starboard bow the giant hull of a British battleship limned itself against the background of haze which overhung the shore. We gave her a wide berth, alter-

ing our course two points to pass well out of her range. Blood was still thicker than water, and when the fight came we preferred it should be with the yellow man.

Searchlights on Watch

Still sailing partly submerged, we were by nightfall twenty miles off Vladivostok, and in full view of a portion of the Japanese fleet which was blockading the harbor. The same rapidity which had marked the attack at Port Arthur was again in evidence.

As the last streak of sun-red faded from the western sky, and the dusk of a moonless night grew quickly over all, another glare began fitfully to light up the scene. From the outlying forts of Vladivostok and from the Russian warships which had hurriedly made for the port, searchlights shot their long, white streams over the water, sweeping wide circles in search for attacking torpedo-boats. Between us and the searchlights of the Russians other lights gleamed over the waves. They were from the vessels of Japan, on the lookout for such as ourselves who might try to gain the shelter of the port. In a long line they stretched, battleships, cruisers, torpedo-boats, from ten miles or more below the city to as far north of it.

Ready for the Rush

"Pretty tough line to buck through," commented Jones, who had played football at college before catching fish in proscribed waters in Lake Erie.

"Gettin' scared?" asked the captain, who saw a chance to get back at the remark about "luck."

"Not what you'd notice, I guess," and Jones pulled out a cigarette and lit it. Strange how touchy a fellow is about his bravery.

We had just slowed down to quarter-speed, poking along to get closer to the shore, and lessening the distance between us and the nearest Japanese, when Jones, who had taken up the receiver of the submarine telephone, spoke again.

"Ship of some sort coming our way," he said. "Can hear her screws. Sounds like a torpedo-boat."

"What direction?" asked the captain.

"On the port bow, about six points. Seems to be going slowly.—Hold on!—'One-two-three, One-two-three, One.' She's signaling. It's our signal, sir."

"Answer her," called the captain. "Here, you,—."

Pick Up a Sister Ship

I dove down the companionway, and in a moment was in the signaling compartment. With the copper mallet I rapped out the signals on the hull, plainly, "One-two-three, One-two-three, One." I repeated them regularly, holding the telephone connecting with the turret to my ear so I might vary them if ordered. In about two minutes the captain telephoned: "It's the *Nixon I.* Tell 'em we're the *Nixon II.*"

"Six-one, six-one," I rapped on the hull. We had picked up a sister boat and would have company in our dash. Good! We might shorten that Japanese line a bit before we got through with it.

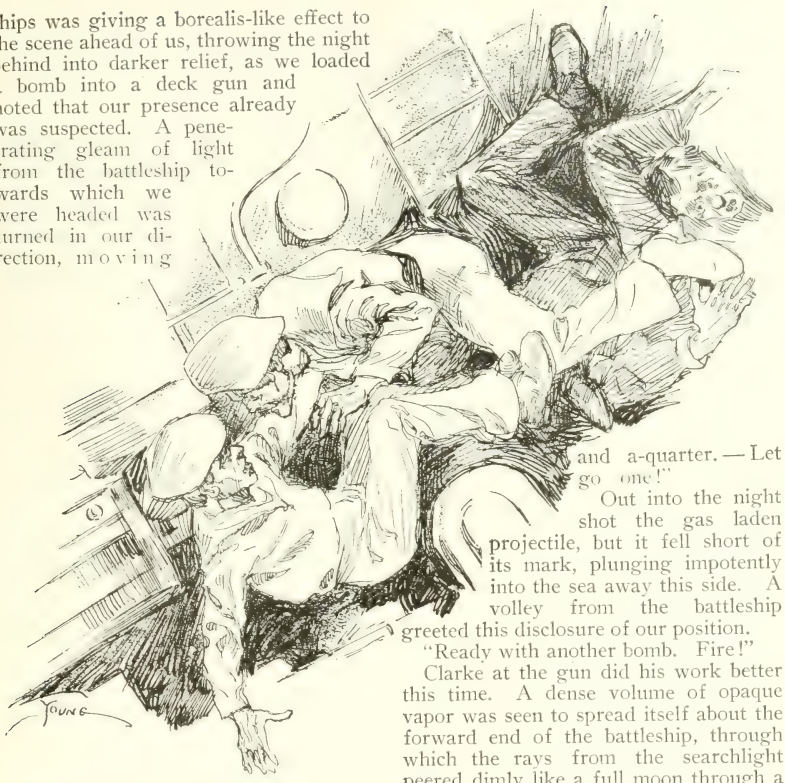
When I came on deck again, the low top of the *Nixon I* was discernible about a hundred feet away on the port side. Both boats were hove to, and the officers were in conference. In half an hour we were under way, headed in the direction of the Japanese battleship, we steering to cross the bows, the *Nixon I* to pass by the stern. Each man was at his post. The captain, Jones, and the second lieutenant were in the conning tower, Jones with the receiver to his ear, with another man in the hold ready to transmit signals under water; the engineering force prepared to change the motive power from boiler-steam to the new motor-explosive, and the gunners made ready the automobile torpedoes, propelled by the same new device.

Deadly Explosives Ready

My post was to superintend the smoke-bombs. These were carried in metallic capsules, packed in an outer casing of shrapnel, each capsule being provided with orifices through which the smoke was to fume off. We had three hundred pounds of the stuff on board, and in one chamber of the bomb we loaded liquefied ammonia gas and in the other liquefied hydrochloric acid gas, with a bursting charge of gunpowder to disrupt the chambers and break up the projectile.

The streaky glare from forts and war-

ships was giving a borealis-like effect to the scene ahead of us, throwing the night behind into darker relief, as we loaded a bomb into a deck gun and noted that our presence already was suspected. A penetrating gleam of light from the battleship towards which we were headed was turned in our direction, moving



"Every man was hurled forward."

steadily back and forth over a fixed area, not as before playing at haphazard everywhere. The motion of our propeller, so audible through the water, evidently had registered its sound on the battleship's receiver.

Firing the Smoke Bombs

But the distance was yet too great for a bomb to carry, and the Japanese gunners would find sound a difficult target to practice at. So we forged ahead to get closer, and did not pay much attention to the long-range shot or two which the Japanese chanced at random, even when one shell struck not a hundred yards away. That gave us an idea of the distance, though, and soon afterwards came the command from Miller: "Ready there with the smoke-bombs.—A mile and a-quarter. — Let go one!"

Out into the night shot the gas laden projectile, but it fell short of its mark, plunging impotently into the sea away this side. A volley from the battleship greeted this disclosure of our position.

"Ready with another bomb. Fire!"

Clarke at the gun did his work better this time. A dense volume of opaque vapor was seen to spread itself about the forward end of the battleship, through which the rays from the searchlight peered dimly like a full moon through a mist. It was the muriate of ammonia formed by the combination of the acid and the ammonia when the bomb burst. Mixing with the moisture of the air the fumes of concentrated sulphuric acid were blinding and stinging and burning all who might be within their reach.

Jap Battleship a Victim

Twice again we fired, both bombs bursting near enough the ship to encircle it with a vapor through which it was impossible for its crew to see. Into the heart of the cloud we fired a torch-bomb, and a flame of acetylene, formed by the igniting of the calcium carbide and water of the projectile, shot up twenty feet and burned with a dazzling, blinding glare.

We were by this time not more than three-quarters of a mile from the battleship which lay at our mercy. But down

the line of investing vessels a commotion was noticeable. Searchlights were playing with an activity which made the lightly rolling waves glisten as under the rays of a dozen moons. Wireless messages, in cipher so that we could not interpret them, filled the air. The dark specks of the torpedo-boats of the Japanese, as they showed up in the flood of light, were seen heading in our direction.

"Now for the torpedoes," came the captain's command.

Blowing Up a Fleet

The two lateral submarine tubes were already charged with ten automobile torpedoes, loaded one after the other like the balls of a Roman candle. In the lookout tower Jones stood by the electrical keyboard and table which controlled their discharge. With a pressure of his finger he released one of the missives. Not a sound marked its speeding from the boat. Generating its own power by steam from a burning explosive, it sped, turbine-propelled, toward its mark. A scarcely audible rumble, a great column of water which rose through the vapor and flame, a drunken reeling of the battleship, then a sickly sagging by the head, and in a few minutes more a plunge foremost below the surface, and only an angry swirl of waters, with a few scraps of wooden wreckage and the awful human debris marked the end of the giant fighter.

Darkness was again about us. Searchlight and torch-bomb no longer lit up the spot where our victim had sunk. Off to the south the dark specks of the oncoming torpedo-boats showed momentarily in the flashes of the warships' lights. Signalling to the *Nixon I* to engage the attention of these, we headed southwesterly, again bearing toward the shore to pass to port of the next Japanese cruiser.

Steaming Fifty Miles an Hour

It was now that we needed more speed than boiler-fed engines could give, and the order went down to change from coal to explosive. Long rods of a compound of nitroglycerine and guncotton, a foot in diameter, solidly encased in steel cylinders which forced the burning from only one end, were attached to auxiliary engines and turbines. A stream of water was turned on, and the explosive, burning without atmospheric oxygen under a pressure of 250 pounds to the square inch, and mixing with the water, generated power equal to 25,000 pounds' pressure per square inch.

As the rush of the new motive was felt on the turbines, the boat, already going at eighteen miles an hour, leaped like a spurred horse lagging in a race, and in a minute we were speeding at a rate little short of fifty miles an hour. A great mountain of water welled up in our wake, following and towering over us to a height above the level of the conning tower. Within the latter the dash of the spray against the armor and the rush of the air made hearing difficult.

Under a Heavy Fire

In five minutes we had traveled four miles, and had hardly realized the great change in our location when a hail of small shot from quick-firers served notice that we were a target for the enemy. Increasing the pressure on the motive, we doubled the rate of combustion, and at a mile-a-minute speed veered our course enough to bring the torpedo tubes in line with the cruiser. Decreasing the pressure again so as not to overtake our own torpedo, we discharged the projectile.

Our judgment in getting so near the enemy had been bad. With greater experience we would have calculated better the enormous speed at which we had been traveling. A terrific impact at the base of the tower, which staggered the boat, followed the bursting of a ten-inch shell aboard of us. For a moment those who were in the tower, stunned by the shock, stood listless at their posts. For a moment only, but in that time we were within six hundred yards of the stricken, reeling cruiser, and no power on earth could stop us in the twenty seconds which would hurl us against her great steel bulk.

Dive under a Warship

"Submerge!" shouted Miller, hoarsely, steadying himself with difficulty and seizing the handle which deflected the rudders. At the same time Clarke threw open the valves of the submergence tanks, and with a shudder from stem to stern as the water swept over our bow, we dove from sight, head on, towards the cruiser's hull.

The engines had been stopped, but the momentum of our speed carried us like a shooting meteor. Ten seconds sooner and we would have passed safely under the warship. As it was, we struck glancingly on her bottom; and the blow of her steel preceded by only a second or two the chug in the mud as we dug our nose into the slimy sea-bed.

Every man was hurled forward, tumbling over one another in the narrow space and bruising up against the parts of the vessel. Jones was the worst hurt, having his shoulder dislocated by a blow against one of the torpedo tubes, with a seaman on top of him. Miller was picked up, with the wind almost out of him, from under a part of the telescope smoke-stack, which had been drawn in before we went into action.

Boat Stuck in the Mud

The boat stuck like a spent arrow, inclined at about forty degrees. We clambered up the bottom to the stern, crowding all our weight aft, hoping we might dislodge her. Then we pumped the water out of the tanks and turned on the motive, reversing the engine and forcing the pressure till we must have been getting 2,000 pounds of steam a minute. The vibration was terrific, shaking the boat so our hands tingled as with a shock of electricity when we touched them against the sides. But the boat never budged, and we shut off the power to save it.

"You fellows can get out through the diving chamber if you want to," said Miller, after we had sat about for a while, not doing much. "Perhaps you could grab a spar or two from the Japanese when their ship goes down." That was more of Miller's sarcasm, but we let it pass.

Doomed to Death

To realize that there is no hope of life does not come all at once to a man. The impracticability of each plan of escape has to be reasoned out separately. We could not believe that this was to be the end of our exploit. We could not realize it all at once, but it came gradually and with finality. It did not alarm us except in that quiet manner which comes upon a man confronted with a certainty. In a collision above water, with a chance for the life-boats, it would not have been the same. We might even have forgotten discipline then, if we were of the panicky sort. But in a steel-clad hull, panic had no impulse to feed on.

"Might as well clear away those things about the machinery," said the captain, finally. "'Twon't do any harm to have matters ship-shape in case we want to start the engine."

We set in their places the articles which had tumbled about. Jones picked up the signaling hammer, which had fallen over near one of the torpedoes. Mechanically he tapped out the fleet signal on the hull—"One-two-three, One-two-three, One."

Wiring for Help

"A little louder than that, or they won't hear you at Vladivostok," said Miller, but the levity passed unnoted.

Jones's hammering suggested the telephone, and I went up to the tower and took down the receivers. "Quit your pounding, Bill," I said to him through the tube, "I want to hear what's going on outside."

A confused agony of sounds smote my ear through the receivers. Borne down from the surface with that strange loudness with which sound travels through water, came what seemed to be the reports of explosions, the cries of human beings, and the anger of an ocean, all mingled in one indescribable concatenation of turmoil. I listened in vain for some distinctive feature of the uproar which might give a clew to a distinctive happening. Then, suddenly, I became aware of an eddying of the waters about us; like the swish of a woman's skirt it sounded, only a hundred times louder and laden with a strange portent of catastrophe. At the same time the stern of our boat seemed to fall away as though being sucked in by a powerful maelstrom. The next moment it yielded before the blow of a great weight, which bore it down with a bruising, grinding force till we found ourselves on an even keel, and then with the stern a trifle lower than the bow.

Struck by Sunken Ship

"That's the Jap," said Jones. "We torpedoed her all right, but it's her revenge now."

"The spectacle fascinated me."

"What did y' expect?" said Miller. "Not satisfied with sinking two of them? Think you were going to bust the whole Japanese fleet with your new-fangled tub?" It was an open secret that the captain never was as enthusiastic over the boat as we who helped to build her.

"That's all right, Cap, but if the fellows on top do as well it won't be such a bad day." Clarke always was cheerful.

I still held the telephone, and it seemed as I listened that we could not be buried beneath the warship or I should not hear so distinctly the sounds which still came through the water. Then I thought of the diving compartment.

"I'm going out to explore, Captain," I said. "Permission accorded, I suppose?"

"No special objections," said Miller. "Bon voyage!" said Clarke.

Inspecting the Wreck

Putting on the diving suit, I stepped into the compartment. The door was closed behind me, and I applied myself to opening the slide which led outside the boat. It required some effort to do this, for the hull had been strained by the two collisions, but finally I succeeded and stepped forth on the bed of the sea.

A sight appalling in its silent tragedy greeted me. Looming in dread majesty fifty feet above the deck of the boat from which I had come, the hull and masts of the Japanese cruiser seemed like a painted picture in a setting of green. In her side yawned the great ragged hole which had been the death wound of the ship. A spar detached itself from a lightly holding weight and rose zig-zag towards the surface; and a human body washed out of a porthole and floated off.

An Unexpected Escape

The spectacle fascinated me, and for a minute I stood awe-stricken at the work of our torpedo. Then I turned to our own boat, and walked around to the stern to see how solidly it had been pinned down. An examination showed that we had received a glancing blow as the cruiser sank, and only our propeller blade was held by a part of the ship's anchor chain. It seemed probable that by starting our engines now we might get clear of the wreck.

Then I went back to the slide and crawled into the diving compartment. As I worked at the gear to close the opening I became conscious of a slight oscillation of the boat as though it were freeing itself from the mud of the bottom. Then the bow began slowly to rise, and a rattling sound at the stern seemed to indicate the loosening of the chain which held the propeller. In a moment I could feel that the boat was mounting rapidly in the water.

Once More on the Surface

When I tapped on the compartment door and it was opened and I once more stood inside, we were on the surface, bobbing up and down with the wash of the waves. It was then that we felt the reaction of escape which, I hold, is no shame even to a brave man. As we opened the portholes and each took his station, we moved in a limp fashion, all trembling, though we tried to hide it.

If the great, dead warship at the bottom of the sea was a tragic sight, the spectacle which appeared above was one to fire the blood. Lurid pillars of flame lit up the sky in patches where torch-bombs had been fired to light an enemy to destruction. The smell of explosives and the noxious fumes of gases drifted with the wind and poisoned the atmosphere. The spasmodic booming of great guns, the sharper report of rapid-firers, the exploding of shells, and the muffled sound of torpedoes bursting under water, mingled in a continuous and varying clamor. The Russian warships in the harbor had emerged to the attack, and from the shore the land batteries threw aërial torpedoes far out to sea. Away on our port quarter, a moving streak of black with a tail foam-flecked and white, flashed into view, disappeared behind a floating cloud of vapor, reappeared beyond it, and was lost in the dark. It was the *Nixon I,* or mayhap *III,* traveling at a mile a minute under explosive motor. Four miles away a great battleship began her death plunge five minutes later.

Watching the Ruin

And we could only watch it all. There, within our hull, were all the potentialities of destruction, and only motion was lacking. The cruiser which had sunk beside us had in its final agony snapped our propeller shaft, and we were no better than a shattered soldier on a hospital couch. Through all the long night we rode idly, helplessly there, and not even a torpedo-boat spied us out. The tide of fight had run southward, and we were far in the wake of it, with two warships somewhere under our keel, and how many more meeting a like fate we could only conjecture. But everywhere we could see in fancy that darting streak of boat and following wave, such as we ourselves had been for too few minutes, and when battleship and cruiser vanished from the blockading line we knew the cause of it.

Life Stories of Successful Men

FRANK HEDLEY

By HENRY M. HYDE

Author of "The Buccaneers," etc.

TWENTY-THREE years ago an English boy of nineteen landed from the steerage at Castle Garden, New York. Besides the clothes on his back he had two pieces of baggage and a few shillings in his pocket. The boy—his name is Frank Hedley—had no friends in America, no influential relatives on whom he could call for assistance. No one would have considered the prospect before him brilliant. But he was not without resources.

He brought with him from England a common school education, a knowledge of the machinist's trade, and an ambition to make a prominent place for himself in the railroad world. Of these three the last was by far the most potent.

Young Hedley started at once on the search for work. Over in Jersey City, in the shops of the Erie Railroad Company, he found a place as a machinist. His daily wages were $2. That provided for immediate necessities, and then, without further delay, he started to prepare for the next step upward along the hard climb he had laid out for himself.

Studied at Night School

A modern manager of transportation, Hedley realized, must have a scientific knowledge of railroad problems and their solution. At a free library he procured technical books, and after working hours he studied them in his room. A little later he heard of the opportunities offered by the Cooper Union night school in New York. Not a minute was lost in enrolling himself among its students. For four years — the length of a university course — Frank Hedley changed from overalls to citizen's clothes every night, after ten hours' hard work in the machine shops, and crossed the river to the old building of the Cooper Union at The Bowery and Third Avenue, New York. When he had finished his course he had a thorough theoretical as well as practical knowledge of machinery.

Is Made Master Mechanic

He was ready now for a change, and he found small trouble in getting a place with the Manhattan Elevated Railroad, where he could put his new knowledge into use. Two years so plainly demonstrated his ability that the King's County Road, over in Brooklyn, made him its master mechanic. Presently the fame of his broadening reputation came to the ears of Charles T. Yerkes, that shrewd judge of men, who was just beginning his astounding career as a traction magnate in Chicago. He took Hedley west with him, and there the young Englishman found a situation developing which might well have baffled and utterly discouraged a less determined and ambitious man. Through his own unassisted efforts he had made himself a practical railroad manager and an expert mechanical engineer. But now it seemed certain that a new and to him unknown force was to take the place of steam as motive power on both elevated and surface railroads.

Electricity Bars His Path

Almost over night the introduction of electricity made Hedley's hard-earned knowledge inadequate and out-of-date. But while Yerkes was making up his mind as to the wisdom of adopting electric power, Hedley was spending his nights in the study of electrical engineering. At the end of five years Yerkes decided to put in trolleys and third-rail electric systems, and he found—doubtless to his own astonishment—that in Frank Hedley he had in his employ one of the most learned and practical electrical engineers in the country.

For the work of transformation which Yerkes wished done there was no one in the United States so well equipped as

the young Englishman. Under Hedley's direction and at his initiative, the Lake Street Elevated in Chicago was the first of overhead lines to discard steam for the third-rail electric system. Hedley built other elevated systems in Chicago and managed them.

FRANK HEDLEY

Is Called Back to New York

Within twenty years, by after-hours' study, he had made himself both mechanical and electrical engineer, and had so perfected his skill as a transportation manager that when the great Manhattan Elevated of New York was looking for a superintendent three years ago its owners offered him the position. To Hedley's progressive spirit and executive ability is given credit for the great improvement in Manhattan Elevated since 1902. And when, more recently, the great New York subway was opened, August Belmont, its chief promoter, handed over to Hedley —now only forty-two years old—the management of the underground as well as of the overhead lines of the great urban transportation system.

Responsible for 300,000,000 Passengers

Every year the elevated and subway lines together carry more than 300,000,000 passengers. For the safety of this vast army of people, Hedley is directly and personally responsible. Under him

are employed more than 12,000 subordinates. His own salary is $25,000 a year.

There are some men who do not have as good a chance as did Hedley to rise in the world; but the number is much larger who, having it, fail to rise because they do not have a fixed ambition; because they are not willing to study after working hours to prepare themselves continually for the next step upwards.

To one who has youth, a common school education, and a knowledge of a trade, the career of Frank Hedley may well serve as an inspiration.

SUBMARINE BOAT *PLUNGER* AT OYSTER BAY.

THE PRESIDENT UNDER WATER.

It was on the submarine boat *Plunger* shown in the illustration above, that President Roosevelt took a trip beneath the surface of the ocean. When it was first reported that the Chief Executive was to go down in the *Plunger*, staid and serious people in all parts of the country threw up their hands in alarm. Wall Street—always nervous—almost went into a panic. To quiet apprehension, it was given out that the President had no intention of going down under water. But when the *Plunger* appeared in Oyster Bay, he could not resist the temptation to try it. He stayed in the depths for more than half an hour, and came up even more enthusiastic than usual.

Sailing on Land

An Amusement that is Rising in Popular Favor and Has Some Useful Applications

By RUTLEDGE RUTHERFORD

SAILING ON LAND is a new diversion, experimented with at different times in the past, that has suddenly burst into prominence.

No other summer amusement conveyance of man's invention can make anything like the speed of the land sailing vessel. It skims over the ground with the actual speed of the wind. Its only rival in amusement conveyances of winter or summer is the ice boat; but the land sailing vessel furnishes much greater enjoyment than the ice boat, for its path is not limited by the narrow confines of an ice pond, and moreover, it is a summer vehicle, made to sail in the season when rapid open-air traveling is really enjoyable. So fast will the land boat move if permitted to go at its full speed during a strong wind, that its occupants would find it impossible to retain their seats. Hence its speed has to be checked and regulated by the manipulation of brakes and sails. From fifty to ninety miles an hour, however, has often been attained with safety when the precaution was taken, of seeing that the passengers were well secured in their seats.

Sailing on land is a sport confined exclusively to the districts "where there is room." It is impossible where there is much traffic, as the sails and rapid speed will not permit of sudden turns and quick stops. At the sea coast summer resorts, on the far away Western plains, and on the deserts of America, the land sailing vessel has made its appearance, and has ushered into existence a new kind of amusement that is destined to become more popular as its charms become better known. It promises to add new interest to the American deserts, for nowhere does the land boat enjoy such an advantageous field as on these open stretches, where it may serve the uses of traffic as well as amusement. Beginning as a pleasure craft, a land boat, placed in service on the Mojave desert in Southern California a few months ago, has now been regularly installed as a transportation vehicle. The vessel in question is known as the *Desert Queen*. It is a real "ship of the desert," and may even result in displacing its namesake on the Desert of Sahara, for now a Chicago firm that has begun the manufacture of this new style of conveyance is negotiating with an English concern with a view to placing a number of the land ships in service on the great African wastes. It is said that a whole fleet of them is soon to be in use on the Mojave desert and in New Mexico.

The *Desert Queen* was built for two miners, Charles S. and Carl L. Hoyt, of Cleveland, O. Since it has been in use it has obliterated many of the horrors that formerly attended the crossing of the desolate Mojave. The Hoyts have a gold mine in the buttes near Rosamond, California. They live nine miles away at the other end of a peculiar dry lake, which is as hard as concrete, and is swept as smooth as a tennis court by the sands that are forever driven over it by the fierce winds rushing through Tehachipi pass.

Substantially constructed through a recent overhauling, the *Desert Queen* is 14 feet long, 8 feet across in front, and tapers to the rear with a mast 15 feet high; mainsail 10 feet on the boom and 10 feet on the mast; jib and jib boom to match. For the front support, an axle not unlike that of a buggy is employed; and to this are attached two iron wheels, each 30 inches in diameter. The rear wheels, also of iron, are 24 inches in diameter. The steerage arrangement is similar to that used on a hook-and-lad-

der truck. The "ship" answers its helm perfectly, and sails about as close to the wind as the ordinary water craft. Just one accident has happened to the *Desert Queen*. That occurred on its trial trip, when it got beyond control. It tore along over the floor of the Mojave, dumping its occupants, and dashed itself to pieces against a rock. Several of the passengers were slightly injured. The vehicle had to be rebuilt; and no further trouble of the kind has since been experienced. It carries its owners and their supply of tools to and from the mine every day, and on holidays and moonlight nights is used for carrying excursion parties.

Excitement enough to suit the most adventurous is afforded by a trip on the *Desert Queen*. As the winged wagon goes bounding along, horned toads scurry away over the burning sands; lizards, like blue streaks, are seen darting to shelter; desert chipmunks of ashen color scatter the sand about in their frenzied haste to get into their retreats; occasionally a coyote, long and gray—the picture of starved want—rises upon his scraggy hind legs and snuffs; now and then the wheels pass over a deadly rattlesnake; and on the quivering machine speeds past the bleaching bones of some poor creature, human or other, that has succumbed to the desert's deadly weapon—starvation.

THREE-WHEELED YACHT.
A type used at Palm Beach, Fla.

Like a white-sheeted specter, shooting noiselessly through the moonlight, there is something uncanny about the appearance of the strange craft at night that scares everything within its view. When it was first put in service stray travelers who met it were frightened almost out of their wits. The Piute Indians were panic-stricken. With wild whoops of alarm they made a rush to get away, the braves trampling the squaws and papooses under foot. Their food was thrown away; and when the strange white monster had gone, the terror-stricken natives prayed throughout the night.

At the bathing beaches of Florida and California, the land boats may be found in the greatest numbers. There the craze has taken such possession of the merry-makers that sails are being attached to all kinds of vehicles—principally the bicycle, which thereby becomes far superior to the motor bicycle in points of speed and easy riding. Moreover, there are now sailing cars, sailing wagons, sailing buggies, sailing automobiles; and nearly everything on wheels at the resorts is being equipped with sails.

But the desert and the seashore are not the only places where the land sail boat finds favor with amusement seekers. In small towns in the country where trees are few, and in other places where there are not many obstructions, the craft may be found exceedingly convenient and entertaining. Like the greyhound it must have a clear and unobstructed country to run in. A Chicago boy has recently built one of the contrivances for use on his vacation. He is Sheldon M. Booth, 13 years old, son of United States Master in Chancery Booth, 4959 Lake Avenue. Master Booth worked conjointly in the construction of the device with Fred Kingsley, Jr., of Minden, Neb., who is 14 years old. Neither of the boys will

claim a preponderance of the credit for the very successful achievement. The product of their labors is called the *Hobo*. It is one of the cleverest contrivances ever devised by two boys. It has four wheels and will seat as many as seven children. The vehicle is 12 feet long and 8 feet wide. It is propelled by a mainsail and a jib. The mast is 11 feet high. The rudder is worked from a rod attached to the right side of the rear axle. The front wheels were obtained from an old cultivator that was out of use, and the rear wheels from a cast-away toy wagon. Thus the entire construction cost the boys less than two dollars. Nevertheless, when painted and trimmed up, it has every appearance of a factory-made affair, and has since afforded ceaseless amusement to nearly every child in Minden, where the boys have been enjoying themselves together during Master Booth's vacation.

The *Hobo* skims along the hard dirt roads of Minden at a breath-taking speed. Moonlight outings on it are the rarest of sports, and have been indulged in by several of the grown people of the town. The craft slips silently through the gloaming like a white-gowned phantom; and on its first trip the inhabitants of Minden were terror-stricken. In the night they could distinguish little more than the ghostly whiteness gliding through the air, and belated travelers fled in terrified amazement, believing it an unnatural visitation. There was much joking in the Nebraska town when the real cause of the fear was made known.

THE *DESERT QUEEN*.

James Fleming of San Francisco is said to be the first person to own a sailing bicycle. He designed it for use at Coronado Beach, where he spends his summers. It is simply an ordinary bicycle with sail attached. Its appearance at the beach led to the construction of many

others, and now at evening the seashore is lined with the "white-winged wheels," which sweep along the sands with a speed of forty miles an hour.

In small towns the sailing vehicles are being built by some for home amusement. One of the most remarkable and successful of these that has recently come to notice, was built by R. S. Trulock of El Reno, Oklahoma, and is called the *Go-Devil,* because of the remarkable speed with which it sweeps along the country roads. Here is what Mr. Trulock says of his real "prairie schooner":

"In building this craft, we took the wheels and axles of a light road wagon, making a platform out of two-by-fours 16 feet long and 2 feet wide, which we hung eight inches under the center of the axles, arranging the rear axle on a pivot with which to steer the craft. Then we placed our four masts at an equal distance apart on the platform. Guying the masts with ropes to the sides of the platform and running out a bowsprit in front, gives us five sails. We also arranged a brake on the front of the wheels, holding it off from the axle by means of springs. The brake is applied by a rope, which, when pulled, will check the machine if not under too great speed. I have found, however, that in very high wind, this brake is of very little use. The only way to stop the machine is by drawing into the wind. The *Go-Devil* cost me in all about $30, but we have had hundreds of dollars worth of fun out of it. It is not practical in anything less than a fifteen-mile steady wind, such as blows in the prairie countries.

"I am now designing a machine which will thoroughly eclipse the present one. It will be 35 feet long when completed, will carry 500 feet of canvas, and will be designed for two persons. I shall take it with me to the Southern coast this summer."

At Palm Beach, Florida, a three-wheeled land yacht shares honors with the winged bicycle in popular favor. Some of these yachts are home-made, being built on three bicycle wheels. The land sailing vessels are so easily constructed that it seems like a useless expense to buy them from the factory now engaged in their manufacture, though the factory-made vehicles are often exceedingly handsome and very substantially built.

The Heroism of Industry

By EDWARD L. MASTERS

HEROES of the battlefield, and heroes of the sea! Of these, how frequently we hear—worthy often, yet often overpraised. But the heroes of peaceful industry in all the commoner walks of life—what of these? Of the farmer delving out yonder in pasture and plow-land; of the swinger of the hammer in the forge; of the builder under whose touch tower and temple spring into proud proportion? What of these world-wide common workers whose ceaseless, uncomplaining toil quickens the pulse and animates the life of nations? Who will sing their pæan—who has written their history and renown?

Toil, the Creator

We have heard among the idlers who float on the surface of society, contemptuous flings at those whose heritage

is toil. They sneer at the hard and horny hand of labor; but they forget that of all that is useful, luxurious, or beautiful on earth, toil has been the creator; that from the marble mansion to the kid gloves of the tailor's most exquisite walking sign, all has been wrought out by human industry. It is the toil of swarthy hands, thou pitiful idler and sneerer—just such hands as thou see'st daily along the curb or in the crowded car—that has reared empires in the Old, and planted republics in the wilderness of the New World; that has hewn the rock in the quarry, built the "miracles in stone" that are the shrines and monuments of nations, and laid the foundations of all great modern industries; that has achieved whatever fame belongs to genius, with the sculptor's chisel, the painter's pencil, and the poet's or scholar's pen; that has winged the ocean with white sails, and exchanged the products of every clime; that has measured the circuits of the stars, and plumed the lightnings to be the swift-winged messengers of man's bidding.

Idleness, a Crime

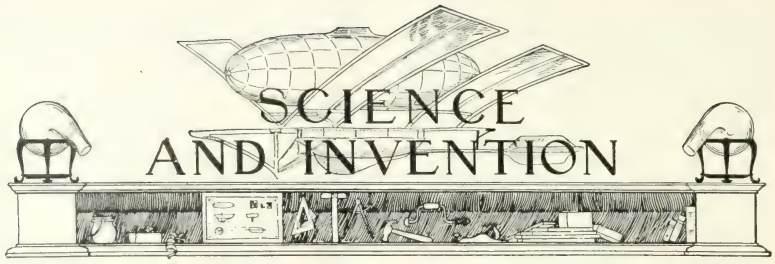
Industry! Why, man of idleness, this is what fed you pap, rocked your cradle, and nursed your pampered life. Without it, the woven silk and wool on your back would still be in the silkworm's nest or in the fleeces of the shepherd's fold. For the meanest thing that ministers to human want, save the air of heaven, man is indebted to toil. It is only drones who toil not, infesting the hives of industry with corruption and decay. The lords of the earth—if they but knew it—are the *men who do things,* who can build up or cast down at will, and who can retort to the sneer of the "soft-handed" by pointing to their trophies wherever art, science, civilization, and humanity are known. Work on, man of toil! Your royalty is yet to be acknowledged, as industry rises toward the highest throne of power.

A Petition

THESE are the gifts I ask
Of Thee, Spirit serene:
Strength for the daily task,
Courage to face the road,
Good cheer to help me bear the traveler's load;
And, for the hours of rest that come between,
An inward joy in all things heard and seen.

These are the sins I fain
Would have Thee take away:
Malice, and cold disdain,
Hot anger, sullen hate,
Scorn of the lowly, envy of the great,
And discontent that casts a shadow gray
On all the brightness of a common day.

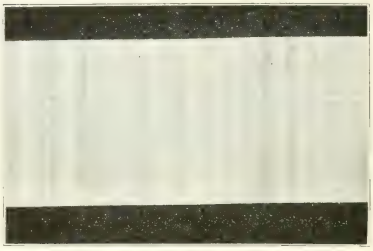
—HENRY VAN DYKE.



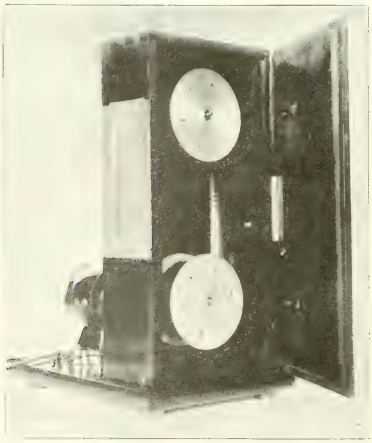
The Photographophone

AN apparatus similar in some respects to the electro-magnetic phonograph brought out by Mr. Poulsen, has recently been designed by Mr. E. Ruhmer, of Berlin, Germany. This apparatus is remarkable for the perfect absence of any disturbing secondary noise.

The underlying principle is the same as the one on which the inventor's optical telephony is based. The "Photographophone" is essentially a cinematograph in its simplest form. In a light-tight box there are two rollers, over which a photographic film is drawn along at a constant speed by means of an electro-motor, passing on its way through the focal line of a specially constructed cylindrical lens which concentrates the light from a "speaking" arc lamp upon the film. The latter, after the record has been made is developed and fixed, when a strip of uniform breadth, including alternate dark and bright vertical lines is noted on the developed film, corresponding closely to any alterations in the candle-power of the source of light at the sending station, and accordingly to the transmitted sound waves.



Reproduction of Film with Sound Record.



Largest Type of Photographophone.

In order to reproduce the language, the "photophonogram" thus obtained, or else a positive obtained from the latter, is drawn along before a similar apparatus at the same speed as when the record was made, while the light rays from an ordinary projection lamp are allowed to strike it. The different shades of the film will result in the light rays from the lamp being absorbed to various degrees, thus producing a varying illumination of a selenium cell arranged behind the film. The latter, accordingly, will be exposed to an illumination of variable strength analogous to an illumination from the light source at the sending station, these luminous variations being converted again into alterations of the electrical resistance of the selenium and thus giving

rise to current oscillations that act on the telephones inserted, whereby the telephonogram is reproduced.

In the case of the distance between the sending station and the photographophone being small, the apparatus simply constitutes a novel photographic phonograph, the lamp used as speaking arc serving in the reproduction as a projection lamp for illuminating the film. In the case, however, of the distance being greater, the apparatus at the same time represents the solution of the problem of simultaneous transmission and recording of the sound waves of the human voice. A special advantage is the fact that both the positive and negative may be used, and that from any original negative any desired number of equivalent positive copies can be produced.

HERR E. RUHMER WITH PHOTOGRAPHOPHONE.

A Non-Refillable Bottle

BY this term is meant, not a bottle which cannot be filled again after once being emptied, but one which cannot be refilled without "telling tales" and bearing evidence that its present contents are not the original. As long as a bottle is not broken, it can be refilled in spite of any device that can be invented. The object, therefore, of a "non-refillable" bottle is not necessarily to prevent refilling, but to detect it if it occurs, and thus to prevent the pilfering, adulteration, or counterfeiting of contents. That, in doing so, it serves a purpose of great commercial importance, is a fact that goes without saying.

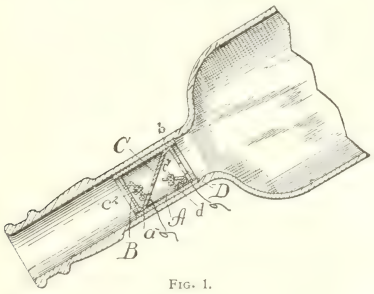


FIG. 1.

Many attempts at a device of this sort have been made. The latest on which a patent has been granted, is the invention of John Sherman Root of Chicago, a graduate of the American School of Correspondence. And it may not be uninteresting to note in passing, that the patent attorney who piloted Mr. Root's application to a successful issue was Miss Florence King, also a graduate of the American School.

Mr. Root's invention combines great simplicity and cheapness of construction with marked efficiency in operation.

In outward form the device is a cylinder (*A*) made of aluminum or other suitable material, which is pushed into the neck of the bottle down near to the shoulder, where a slight convergence of the glass sides prevents its further in-

gress. Inside this cylinder is the essential part of the invention, consisting of a sheet of metal (preferably aluminum) cut with such outline, and so bent, as to form three sections—a top (*B*), a diagonal (*C*), and a bottom section (*D*)—each closing the passage through the cylinder *A*. In the bottom section at *e*, and in the diagonal at *c* (Fig. 2), are apertures closed respectively by valves *é* and *d*, which swing outward only when forced to do so by the out-passing liquid when the bottle is inverted, as in Fig. 1. The liquid makes its final exit through apertures at *E* (Fig. 2) in the top section. Vents for ingress of air for displacement, are provided in the needle-hole aperture e^3 (Fig. 2) and the small openings around the valve hinges.

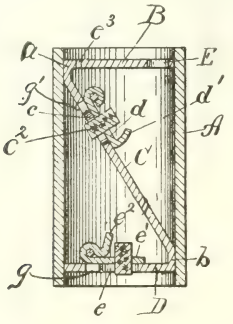
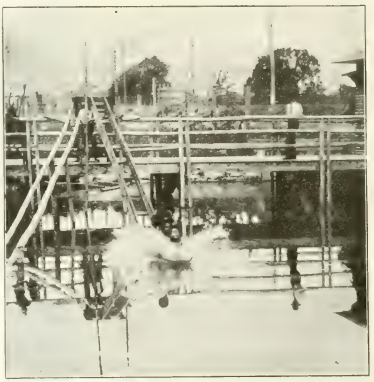


FIG. 2.

An attempt to refill the bottle will at once defeat itself by closing the valves; while the position of the middle-section valve *d* (Fig. 2), relative to aperatures *E*, insures its immunity from tampering by the insertion of a wire or other instrument.

A Water Toboggan

THE camera sometimes reproduces views which surprise the photographer, but seldom has an odder picture been made than the one here illustrated. It was intended to be a snap-shot of some little Filipinos sliding down a water toboggan; and, as will be noted, the boys were caught just at the moment they entered the water. Reversing the picture, however, a very artistic view is



FILIPINO BOYS IN WATER TOBOGGAN.
A "topsy turvy" picture.

presented of a bridge with houses on either end. The bridge is ornamented with one of the Filipino totem poles. The chief peculiarity of this part of the view is that it shows the boat which is used for the toboggan, but which is not plainly revealed in the other picture. The reversible photograph was, of course, caused by the perfect reflection of the water.

Collapse of Huge Balloon

BALLOONS do not always go up on time, or as advertised to do. Very recently one failed to "make good." In addition, there was great excitement, confusion, and not a little peril. There was to be an ascension made by the famous aëroplane invented by Prof. J. J. Montgomery, of Santa Clara, at Oakland, Cal.

To carry aloft the aëroplane and its operator, it was necessary to employ a huge hot-air and gas balloon. A large quantity of straw saturated with coal oil was being burned, and the smoke and gas forced into the immense canvas bag. Besides being anchored with ropes, the balloon was held down by a great number of men, who stood around the lower part, grasping the canvas. The immense bag filled rapidly and constantly increased in buoyancy, until it required the united strength of all the men to hold it.

Just about the time to cut the ropes and loosen hold, there was a great collapse. Suddenly the gas pressure tore a big hole, which increased, rending asunder the giant bag from top to bottom. The collapse was accompanied by a loud puff-

COLLAPSE OF BALLOON.
Photo taken at instant it occurred.

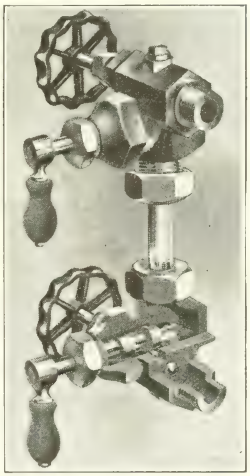
ing noise as pent-up gas, smoke, and heated air burst forth. Panic seized the spectators, who rushed away in great alarm. Many of those holding the balloon were more or less burned, while a number were overcome by the gas and sank to the earth. Some had a narrow escape from asphyxiation. However, no one was killed, though the escape was narrow.

Shallow Automatic Water-Gauge

THE accompanying illustration shows a water-gauge which has been designed to shut off automatically the escaping water and steam when a gauge glass breaks. It is a well-known fact that where gauge glasses are provided on locomotives, the engineers frequently throw them out of service and depend entirely upon their try-cocks to inform themselves as to the amount of water in the boilers. A common excuse for this practice is that the danger from a broken glass tube is greater than from anything else in the locomotive.

The Shallow gauge is of exceedingly simple construction. The automatic valve is not subjected to wear, except when it is closed through the breaking of a glass. As this occurs only at long intervals, there will be no appreciable wear for years. The whole valve is constructed of brass, and is designed so that no trouble is experienced from the collection of sediment or scale.

The action of the gauge is said to be so instantaneous that in almost every case some water will remain in the bottom of the broken tube after the valve closes. A new glass can be inserted at once, without any preliminaries; and as soon as it is in place, it is put into service by a single turn of the two automatic handles.

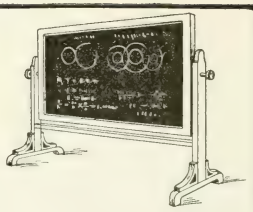


SHALLOW AUTOMATIC WATER-GAUGE.

The advantage of a gauge of this sort in connection with pressure tanks for elevators, etc., is as obvious as in the case of boilers.

CHALK TALKS

by CARL S. DOW.



Number Twenty-Two—The Injector

THE water in the boiler is evaporated into steam, and this steam passes over to the engine. If this continues without more water being added to the boiler, it will be but a short time before the boiler is empty.

The water must be replenished as fast as it is used, for low water will surely result in injury to the boiler, if it does not cause rupture. When the steam pressure is slight (5 to 15 pounds per square inch), as in many boilers used for heating dwellings, the water may be supplied from the city mains, as it is under sufficient pressure. But what is to be done when the pressure is over 100 pounds?

Feeding the Boiler

In order that the water may enter the boiler, it must be forced in; it must be under a pressure that is in excess of that in the boiler. There are three ways to feed water to boilers: the pump, the return steam trap, and the injector.

In the pump, the excess of pressure is obtained by making the steam piston larger than the water piston. In the steam trap, steam is admitted to the surface of the water to be supplied to the boiler, thus making the pressure in the trap the same as in the boiler. The excess of pressure is obtained by placing the trap a few feet above the boiler, so that the pressure due to this height will cause the water to flow into the boiler by gravity.

The Injector

The injector is an instrument having no mechanism whatever, unless the valves controlling the flow of water and steam are called mechanisms. It is nothing but a tapered nozzle within the pipe leading to the boiler.

It seems wonderful, until one looks into the matter, that the steam can overcome its own pressure and yet have sufficient energy to force the water into the boiler. Let us see how it is done.

In the first figure on the blackboard, B represents the cross-section of the boiler, and S a steam pipe leading from the steam space. At the end of S is a nozzle or cone-shaped portion N. P is a pipe leading from the feed-water tank T, which may or may not be below the boiler. This pipe P surrounds the nozzle N as shown. The pipe F leads to the boiler, and has within it the check valve H, which allows water to enter the boiler, but will not let it flow in the reverse direction.

When the valve V is opened, steam flows rapidly out of nozzle N and carries with it some of the air in the pipe P. This causes a reduction in air pressure in P, and as the atmospheric pressure is acting on the surface of the water in the tank T, some water flows up the pipe P.

As the cold water comes in contact with the nozzle it condenses a part of the steam within it. The particles of water (condensed steam) are flowing rapidly and they give their motion to the water. The mixture of feed water and condensed steam then flows through pipe F and through check valve H into the boiler.

Velocities

Let us suppose steam and water are under pressure in a boiler and that steam is escaping from a small pipe lead-

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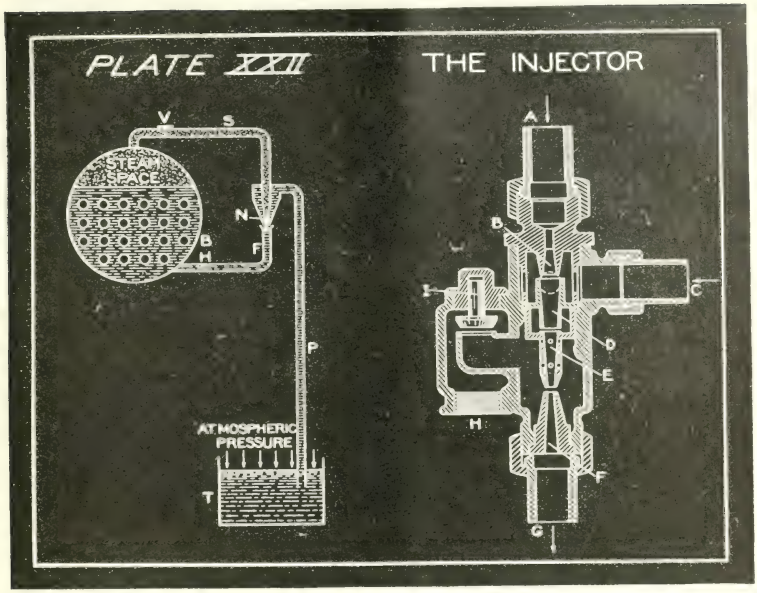


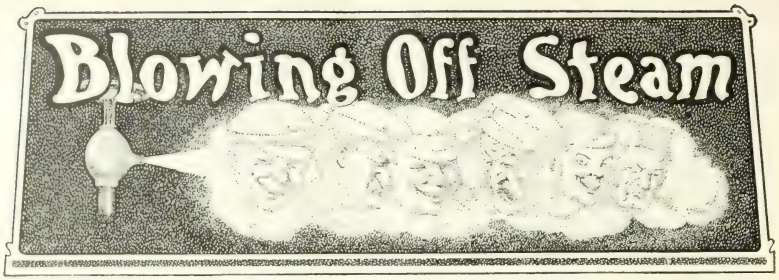
ing from the steam space, and water is flowing from the water space. The steam and water are under the same pressure, but the steam will escape about 15 times as fast as the water.

If now the steam is suddenly condensed, the small particles will move on with practically undiminished speed. If this rapidly-moving steam meets the outflowing water it will easily overcome its pressure. In practice, the rapidly-moving stream sets in motion a much larger body of water, and although the velocity of the larger quantity is much less than that of the small stream, yet it is sufficient to overcome the boiler pressure.

The water thus forced into the boiler has a smaller *volume* than the steam used, but its weight is greater, therefore an increase in the amount of water in the boiler results. It may be said that a small mass of water (condensed steam) moving at high velocity forces a large mass of water into the boiler at low velocity.

The second figure on the blackboard represents the section of a commercial type of injector. The steam enters at A and flows through B, thus drawing water through pipe C. The large volume of water flows around among the parts of the injector and out of the overflow H; of course it cools the injector. This flow continues until the condensed steam establishes the current through the combining tube E, the delivery tube F, and the pipe G to the boiler.

When the flow is once established, the overflow check I drops, and the stream continues to go to the boiler.



Does the Work

"If," said the chemist, "you will give this new tonic a trial, I'm sure you will never use any other." "Excuse me," rejoined the customer, "but I prefer something a little less fatal."

Fortunate Indeed

An old darky was taken ill, says the *New York Times,* and called in a physician of his own race. After a time, as there was no signs of improvement, he asked for a white doctor.

Soon after arriving, Doctor ——— felt the old man's pulse, and then examined his tongue.

"Did your other doctor take your temperature?" he asked.

"I don't know, boss," replied the sick negro. "I hain't missed anything but my watch as yit."

The Family Circle

An Irish lady, the wife of an ecclesiastic in Scotland, lost her old mother. Her friends gathered to condole with her, and made her take comfort in the thought that her husband and children were left to her.

"Yes," she replied. "But she was different. She was my own mother. My husband and children are, after all, only related to me by marriage."

Man's First Estate

"I must confess," remarked Mrs. Crabbe, "I don't believe there ever was a really perfect man."

"Well," replied Mr. Crabbe, "Adam would have been perfect, I suppose, if Eve had only been made first."

"How do you mean?"

"Well, she would have bossed the job of making Adam."—*Philadelphia Press.*

Believe Me

Miss Oldgold: "Before I give you my answer, count, tell me one thing. When my freshness of youth is gone, and the hand of time has dimmed whatever beauty I possessed, when advancing years cause my cheeks to fade and my charms to vanish—tell me, count, will you love me then?"

The Count: "I do."

Not Formally Introduced

Uncle Nehemiah, the proprietor of a ramshackle little hotel in Mobile, was aghast at finding a newly arrived guest with his arm around his daughter's waist.

"Mandy, tell that niggah to take his ahm 'way from 'round yo' wais'," he indignantly commanded.

"Tell him yo'self," said Amanda. "He's a puffect stranger to me."—*Lippincott's Magazine.*

Great Hurry to Get to Work

Mrs. Hogan—An' how did the baby git the fall?

Mrs. Grogan—His father wor houldin' him in his arms whin the whistle blew. —*New York Mail.*

Shingles are Scarce

La Montt—"Children are so much worse than they used to be. What do you attribute it to?"

La Moyne—"Improved ideas in building."

La Montt—"What has that to do with it?"

La Moyne—"Much. Shingles are scarce, and you can't spank a boy with a tin roof."

Home Luxuries

SHE always darned her hose with silk—
The holes were quite extensive—
The price of silk was very high,
Which made them darned expensive.
—*Grand Rapids Herald.*

How the Clergyman Endorsed a Check

ONE of the stories attributed to Bishop Potter concerns a young and inexperienced clergyman who had just been called to a city charge. At the end of the first month his salary was paid by check, and he took it to the bank and passed it in at the paying teller's window. That official looked at it and then passed it back.

"It's perfectly good," he said, "but I will have to ask you to endorse it."

The young clergyman took his pen and wrote across the face of the check, "I respectfully subscribe to the sentiments herein expressed."—*Search-Light.*

Colored Wisdom

We all would 'a' been richer, ef we'd only been wiser; but maybe we'd been baldheaded, wid no appetite.

Don't worry too much 'bout de world. W'en you come ter think 'bout it, de world don't waste two minutes worryin' 'bout you.

Even de preachers takes a vacation, en leaves de sinners ter settle de problem of hot weather here en hereafter.

Poor Willie

WILLIE to the circus went,
He thought it was immense;
His little heart went pitter-pat,
For the excitement was in tents.
—*Harvard Lampoon.*

The (W)hole Cheese

LITTLE Billy came in one afternoon from an assembly of the children of the neighborhood, with his clothes pierced above and below with a great many holes. "For pity's sake!" exclaimed his mother. "What has happened to you?" "Oh," said Billy, "we've only been playing grocery store, and everybody was something in it. I was the Swiss cheese."—*Detroit Tribune.*

A Body Blow

AT one of the recent lectures by Prof. George Kirchwey, dean of Columbia Law College, New York, the students were uneasy. There was something wrong in the air. Books were dropped, chairs were pushed along the floor. There were various interruptions. The nerves of all were on edge. The members of the class kept their eyes on the clock and awaited the conclusion of the hour of the lecture. The clock beat Professor Kirchwey by perhaps a minute, but at the expiration of the schedule time the students started to their feet and prepared to leave. "Wait a minute," objected Professor Kirchwey; "don't go just yet. I have a few more pearls to cast."—*Argonaut.*

Condensation

Wee Miss—Mamma, mayn't I take the part of a milkmaid at the fancy ball?

Mamma—You are too little.

Wee Miss—Well, I can be a condensed milkmaid.

Eddie was too Literal

"EDDIE," said a mother to her little son, "I wish you would run over and see how old Mrs Smith is. She has been quite ill."

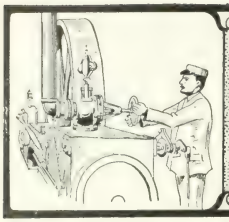
In a few minutes Eddie came running back and reported: "She said to tell you it was none of your business."

"Why, Eddie," said the astonished mother, "what did you ask her?"

"Just what you told me to," replied the little innocent. "I told her you wanted to know how old she was."

In the Year of Our Lord, 2000

Give me a spoon of oleo, ma,
And the sodium alkali,
For I'm going to make a pie, mamma!
I'm going to make a pie.
For John will be hungry and tired, ma,
And his tissues will decompose;
So give me a gram of phosphate,
And the carbon and cellulose.
Now give me a chunk of casein, ma,
To shorten the thermic fat.
And give me the oxygen bottle, ma,
And look at the thermostat.
And if the electric oven is cold
Just turn it on half an ohm,
For I want to have the supper ready
As soon as John comes home.
—*Cleveland Leader.*



ENGINEERING PROGRESS

Great Floating Dock

THE city of Rotterdam, Holland, early in October, 1904, put into operation her fourth iron floating dock, built by Mr. August Klönne, of that city. Contracts for this gigantic construction were granted in June, 1902. The dock, which is one of the greatest of its class in Europe, is 170 meters (557.7 feet) in length, and 36 meters (118.1 feet) in external breadth, the height of the pontoons being 4 meters (13.1 feet) and the total height, 14.6 meters (47.9 feet); its bearing power is as high as 15,600 tons. Two docks which have been in operation in Rotterdam since 1883, are 48 and 90 meters (157.5 and 295.3 feet) in length, respectively, their breadth 27.4 meters (89.9 feet), and the height of pontoons 3 meters (9.8 feet); while a third dock opened in 1903, is 110 meters (360.9 feet) in length, 27.4 meters (89.9 feet) in breadth, and 3.5 meters (11.5 feet) in height of pontoons.

The new floating dock illustrated herewith, whose installation was commenced January 19, 1903, includes 7 pontoons, each of which weighs 600,000 kilogrammes (661 tons), the total weight of the dock being as high as 6,500,000 kilogrammes (7,165 tons). The 7 pontoons are separated from one another by an interval of 0.6 meter (2 feet), while the upright side caissons form a continuous system. Each pontoon has two centrifugal pumps installed in an engine gallery in the lateral caissons, one on each side, which are operated through a vertical axis by a 35-horse-power motor. The pumps are placed on the bottom of the pontoon, where they are mounted in a pit free from water. They suck the water through two pipes from a tank, which also is located at the bottom of the pontoon. In addition, running throughout the length of the dock, there are the suction pipes of four Lenz pumps, drawing the last traces of water from the pontoon; these also are driven by motors.

As soon as the dock has been sunk

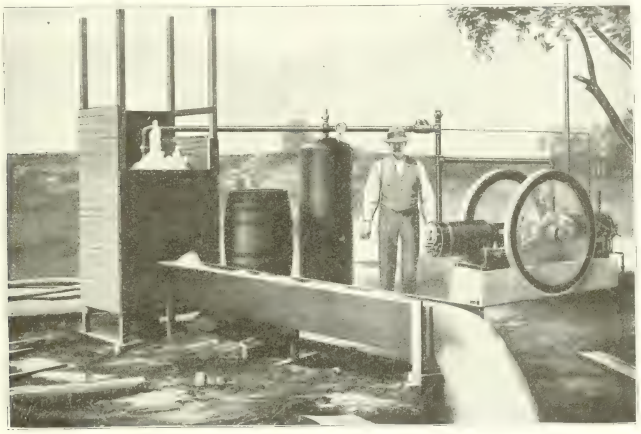
GIGANTIC FLOATING DOCK AT ROTTERDAM, HOLLAND, IN COURSE OF CONSTRUCTION.

by the entering water, the ship to be docked is hauled in by means of electrically operated winches placed at either side of the dock. In addition to the motors above mentioned, 22 in number, there are 25 motors serving to control the electric power for the operation of an equal number of levers, so that the inspector of the dock is enabled to control the level of the water in the pontoon in case the dock contains a ship not taking up the whole of the construction, or in case two small vessels are berthed at the same time. After the ship has entered the dock, pumping is commenced, while, at the same time, the men shift by means of winches the struts which locate the ship accurately in the center. Further wooden struts are placed in position, insuring the equilibrium of the ship. The entire docking process requires two hours.

The interesting work, which was designed on the plans of Mr. de Jongh, and mounted under the supervision of Messrs. Nobel & Roosen, involved an expenditure of about $550,000.

Pumping by Compressed Air

A NEW arrangement for pumping water by means of compressed air, devised by a Chicago manufacturing firm, makes it necessary only to connect up the air-line between the compressor and the well, and extend an air-pipe into the well-casing. The air discharged into the well through the feed pipe literally lifts the water out of the well. The compressor possesses a great advantage for this kind of work, in that there are no moving parts to wear or get out of adjustment or require packing. Wells which yield a large amount of sand would quickly fill up the working cylinder, causing endless trouble and frequent shut-downs under other methods of pumping; whereas, with the air-jet system, sand is carried out along with the water.



PUMPING WATER BY COMPRESSED AIR.

The new method utilizes the well to its maximum capacity. Since the device was perfected, the installations are being successfully used for irrigation purposes; and many wells that had ceased to flow are, by means of a small compressor, brought again into use. Frequently they give out a larger quantity of water than when the natural flow of the well was used.

The engine and compressor are automatic, requiring practically no attention after the engine is started and the oil cups are filled. The outfit, being self-contained and compact, necessitates no special foundation. Not only is it suc-

cessful for the purposes of obtaining water, as described, but of late the device is being successfully used also in pumping oil in the Kansas and Texas fields.

Berlin Light and Power Plant

ONE of the oldest and at the same time one of the most complete electric light and power systems in the world is possessed by Berlin, the German imperial capital. It is controlled by the Berlin Electricity Works, which operates six large stations in the city and suburbs. These stations furnish current for lighting and motors, as well as for extensive electric traction lines. Each of the six stations forms a complete generating plant.

The largest of the four Berlin central stations, as well as the oldest, is the Schiffbauerdamm-Luisenstrasse station. The plant is a combination of two large central station buildings which lie adjoining on the same ground. As far as the electrical and mechanical equipment is concerned, however, each station is a completely independent plant. The two are connected by a system of cables, so that they can supply the same circuits when necessary. The Schiffbauerdamm plant proper supplies the lighting current and is composed of a boiler house and dynamo room, together occupying an extensive building. The Luisenstrasse plant generates current for the different tramway lines, but can be used as a reserve to help out the lighting station when an extra supply is needed.

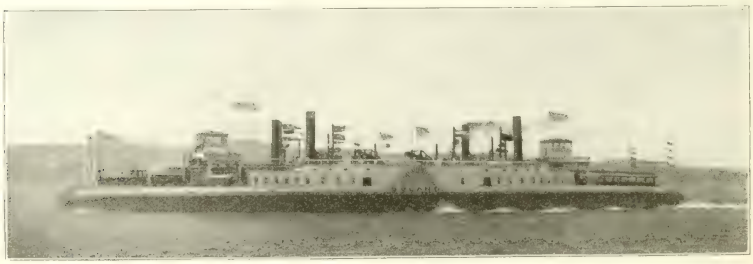
The boiler room of the Schiffbauerdamm station, shown in the illustration,

is a model of modern and convenient construction. There are two large chimneys that give it an imposing appearance from the outside. The room contains eleven water-tube boilers, disposed in two rows, one on each side of the station, leaving a space in the center for the coal. Six of the boilers have a heating surface of 303 square meters, while the other five have a capacity of 452 square meters.

The dynamo room is entered from the boiler room and contains five upright engines of great size and power. The engines are direct-coupled to the dynamos, the latter being mounted in pairs on each side of the engine, making a total of ten dynamos for the station.

Father of All Ferries

"SOLANO," the great Southern Pacific ferryboat, which plies between Benicia and Port Costa, California, has a capacity of forty heavily loaded cars and two locomotives at a single trip. The boat is 430 feet long and 116 feet wide,



LARGEST FERRYBOAT IN THE WORLD.

and its two engines are of 2,000 indicated horse-power.

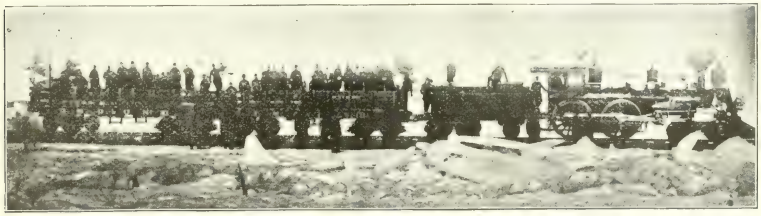
Solano handles an average of 10,000 trains a year. On a single day it has made forty-two trips, crossing the strait, which is a mile in width, in about thirteen minutes.

It is believed that *Solano* is now the largest ferryboat in the world.

A Novel Roadbed

THE St. Lawrence river becomes covered with a coating of ice in winter so thick that frequently railroad tracks are built out upon the ice, and used for the transportation of engines, cars, and freight. The accompanying photograph shows such a track built on the St. Lawrence in the suburbs of the city of Montreal. Timbers were first laid upon the surface of the ice itself, and held together by iron cleats spiked to the ends. Then ties were spiked to the timbers, and the rails fastened upon these. The photograph shows the first train over the novel railroad track at a point several hundred feet from shore.

ORNAMENTAL ARCH OF BROOM CORN.



RAILROAD TRAIN BORNE ON ICE IN ST. LAWRENCE RIVER, NEAR MONTREAL.
The locomotive and cars here shown belonged to the Quebec, Montreal, Ottawa & Occidental Railway, now a part of the Canadian Pacific System.

Broom-Corn Arch

THIS structure, which closely resembles the wall of a castle of the olden time, is not made of stone or even of wood, except the framework, but of broom corn. The tassels, stalks, and other portions form the entire face of the structure as well as the decorations. The material was fastened to a light wooden framework so deftly that the latter is completely hidden by the decoration. This idea was used to ornament a street in an Illinois town during a carnival which was held during harvest time, and formed one of the interesting spectacles of the display owing to its mammoth proportions. The arch shown in the center was of such size that a wagon and two horses could easily be driven through it.

In order to receive attention, all inquiries must be addressed to the Consulting Department, and must be accompanied with the *full name and address of the sender*. In view of the fact that the inquiries already received have far exceeded the available space, the Editors reserve the right to select for publication only those inquiries likely to be of greatest interest to the readers of the magazine in general. Other inquiries will be answered by letter.

Air Brakes

Question: When taking up the slack of the brake shoes, how far should the brake piston move in the cylinders on cars and tenders with the full application of the air brake? —*H. R. C.*

Answer: Not less than six inches and no more than eight inches.

Question: When the air brakes go on suddenly when not operated by the engineer's valve, and the gauge pointer falls back, what is the cause and what should be done?—*H. R. C.*

Answer: Either a hose has burst or conductor's valve been opened, or the train has parted. The handle of the engineer's valve should be immediately placed in the lap position to prevent the escape of air from the reservoir.

Question: Are air brakes liable to stick on after an emergency application, and if so, why?—*H. R. C.*

Answer: The brakes are harder to release after a severe application because they are on with full force and it requires higher pressure than usual in the train pipe to release them again. In this case it is necessary always to have in reserve the excess pressure of the train reservoir to aid in releasing the brakes. With a quick triple valve this is especially necessary because air from the train pipe as well as from the auxiliary reservoir is forced into the brake cylinder, when a quick application of the brake is made, thus increasing the pressure in the brake cylinder without the usual reduction of pressure in the auxiliary reservoir, and requiring a high pressure in the train pipe afterward to cause the brakes to be raised.

Question: If the train is being drawn by two or more engines, upon which engine should the brakes be controlled, and what must the engine men of the other engine do?—*H. R. C.*

Answer: The brakes must be controlled by the leading engine and the engine men of the following engine must close the cock in the train pipe just below the engineer's valve. The pumps of the rear engine must always be kept running and in order and the main reservoir charged, with the engineer's valve in the running position so that he may quickly operate the brakes if called upon to do so.

Safety-Valve Adjustment

Question: The area of a safety valve is 10 square inches and its weight is 14 pounds. The weight of the lever is 22 pounds, and its center of gravity is 28 inches from the fulcrum. The length of the lever is 40 inches, and the distance from the fulcrum to the point of attachment of the valve is 4 inches. What will be the weight of a ball that just balances a pressure of 90 lbs. if the ball is placed at the end of the lever?—*C. R.*

Answer: In solving a problem of this sort we know that the product of the total steam pressure on the valve, multiplied by the distance of the valve from the fulcrum, equals the sum of the three

weights each multiplied by their respective lever arms, as follows:

$$\begin{array}{rr} W \times 40 = & 40W \\ 22 \times 28 = & 616 \\ 14 \times 4 = & 56 \\ & \overline{40W + 672} \end{array}$$

The steam pressure being 90 lbs. per square inch, and the area of the valve being 10 square inches, you have 10×90 as the total power. Therefore $40W + 672 = 10 \times 90 \times 4$. $40W = 2{,}928$; $W = 73.2$ lbs. The ball to be placed at the end of the lever, therefore, should weigh 73.2 lbs.

Fly-Wheel Speed

Question: I have a ten-foot cast-iron fly wheel with pad joint, running at 120 revolutions per minute. Is this too great a speed, and how do you calculate the speed for bursting? —*R. L. W.*

Answer: The speed of your fly wheel is not too great, as it could easily stand 135 revolutions per minute and still have a margin of safety of about 3. For a given material there is a definite speed at which disruption occurs regardless of the amount of material used. The formula is

$$V = 1.63 \sqrt{\frac{SE}{W}}$$

V equals velocity at the rim of wheel in feet per second, W the weight of a cubic inch of material used, S the tensile strength of 1 square inch of material, and E the efficiency of the rim joint ($E = 1$ for wheels without the rim joints, .25 for flange joint, .50 for pad joint, and .60 for link joint). The above value of V is of course theoretical. If instead of the tensile strength the safe strength is used, the result will be the speed of the rim in feet per second at which the wheel may run with safety. This of course assumes that the rim is made in one piece of homogeneous material and free from shrinkage strains. Using your problem as an illustration, you would have

$$V = 1.63 \sqrt{\frac{10{,}000 \times .50}{.26}},$$

the weight of cast iron being .26 lb. per cubic foot, and the tensile strength could be depended upon to be 10,000 lbs. Reducing by multiplying 10,000 by .50, dividing by .26, and then extracting the square foot of the result, and multiplying by 1.63, will give you the velocity in feet per second. Multiply this by 60 to obtain the velocity in feet per minute. The circumference of your fly wheel being 10×3.1416, you should divide the above result by 31.416 to find the number of revolutions per minute to burst it.

Tests for Building Stone

Question: How are stones tested?—*W. L. B.*

Answer: The relative enduring qualities of different stones are usually ascertained by finding the weight of water that they will absorb in a given time, and as a rule the best stone is that which absorbs the smallest amount of water. In some cases, the stone to be tested is already soaked with water and in that condition is very soft and easily worked. It gradually dries and becomes hard and durable on exposure to the atmosphere. In order to find the power of the stone to absorb water, weigh a sample carefully after it has been dried. Then immerse it in water for twenty-four hours and weigh again. The increase in weight will be the amount of absorption.

To test the stone in regard to the effect that frost has on it, immerse a sample in a concentrated boiling solution of sulphate of soda. On being allowed to dry for a few days in the air, the salt crystallizes in the pores of the stone and particles are broken off. Weighing the stone before and after will show the weight broken off. The greater this is, the worse the quality of the stone.

There is also the acid test. To find whether a stone contains matter likely to be dissolved by the gases contained in the atmosphere, it is soaked for several days in water containing 1% of sulphuric and hydrochloric acids. If it does contain such matter, the water will become more or less cloudy or muddy.

Direct-Current Transformation—Frequency and Cycle

Question 1: Will you kindly tell me if there is such a thing as a static direct-current transformer. If so, please explain its operation.

Question 2: What is the difference between the frequency and the cycle of an alternating current?—*W. P. S.*

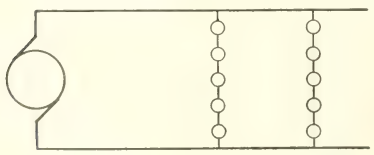
Answer 1: We are not familiar with any such piece of apparatus as a static transformer, or transformer without moving parts, which will transform direct current from one voltage to another. The most common way to change the voltage of a direct-current circuit is to use a motor generator or dynamotor.

Answer 2: A "cycle" is the series of changes which take place in the current or voltage of an alternating-current circuit during the revolution of a simple coil in a bipolar field. The current or voltage starts first at zero, increases to a maximum in one direction, and falls to zero, then increases to a maximum in the opposite direction and returns to zero. By "frequency" is meant the number of cycles per second.

Number of Lights in Series

Question: We have a dynamo for flour bleaching—500 volts, 3½ K. W., 7 amperes. We are using 4 amperes for flour bleaching. How many 100-volt lights could we run if we wired them in series of 5; also, is the drawing shown below correct?—*H. C. D.*

Answer: If your power for bleaching requires 4 amperes, you will then have left 3 amperes of current for supplying your lights. If you use a 16-candle-power incandescent lamp having an efficiency of 3½ watts per candle-power, then each lamp would require .56 of an ampere at 100 volts, and you could



run as many series of lamps as times .56 is contained in 3, which is 5 in round numbers. You could accordingly run 5 groups of 5 lamps each in series, or 25 lamps. They should be connected up as shown in your sketch, which is entirely correct.

Voltage on Lamps

Question: What kind of conductor should be used for carrying electric current for lighting purposes a distance of 25 miles, and what percentage of wastage should there be?—*F. C. W.*

Answer: In this case we should advise the use of copper wire, and you could allow for a loss of from 7 to 10 per cent, depending somewhat upon local conditions.

Lamps in Series

Question: If the station transformer were to burn out, where or how could I get my proper voltage? Could I get it by connecting 10 lamps in series across the primary mains, the primary voltage being 1,150, and the secondary 115?—*W. H. B.*

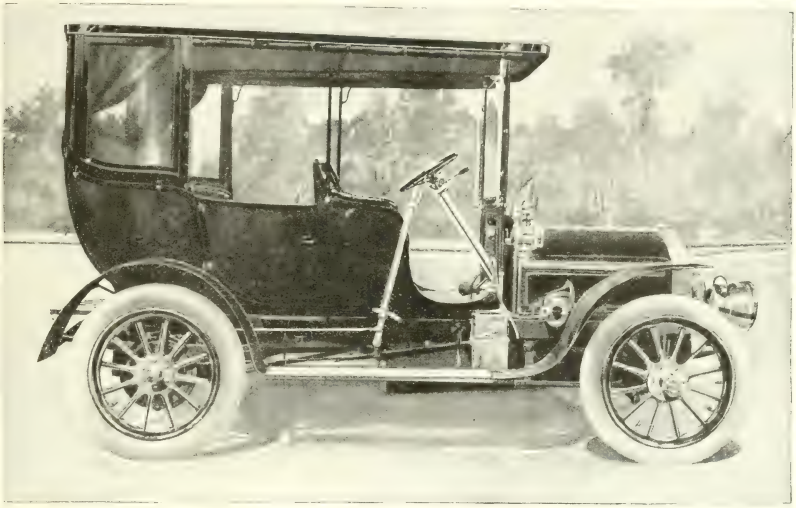
Answer: If you connected ten 115-volt lamps in series across your 1,150-volt primary circuit, then each lamp would get its proper amount of current and would glow at normal candle-power, as the voltage required for a number of lamps in series is equal to the sum of the voltages required by each individual lamp. Thus in car-lighting, five 110-volt lamps are put in series across the 550-volt circuit. We would not, of course, recommend this scheme of putting 10 lamps across the 1,150-volt mains for general use; but, as stated, you could obtain proper voltage for your lamps in that way.

Stuttering Telephone

Question: Will you please give me the cause and remedy of a telephone stuttering as if some one had short-circuited it? It will cut clear out for a minute or so, and then go all right again. The telephone is of the bridging type.—*P. A. J.*

Answer: Your trouble is more than likely due to a loose connection. A swinging short on the line would cause trouble of this kind, but you should get side tone, otherwise line connections or instrument wiring are in trouble.

PIERCE



This is a rather good picture of the Great Arrow Victoria Tonneau. 40-45 H. P., with semi-enclosed top, made by the George N. Pierce Company. Price, $5,000. Semi-enclosed top, extra, $350. Cape top, extra, $150.

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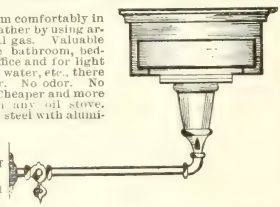

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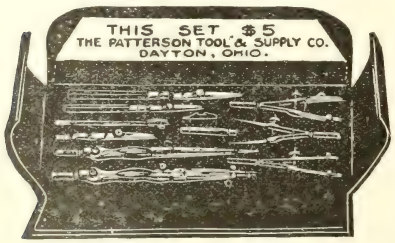

BOOKS RECEIVED

Wireless Telegraphy: Its History, Theory, and Practice. By A. Frederick Collins. Cloth. Illustrated. Pages 300, 6 by 9 inches. Published by McGraw Publishing Co., New York. Price, $3.00.

THIS book should prove a welcome and valuable addition to the present literature on Wireless Telegraphy, about which so little is generally known, and yet to which such a live interest is attached. The author is a man who has had a great deal of practical experience in the wireless field, and has presented the results of his investigations in a concise and understandable manner, with numerous illustrations.

Both the expert and the layman should find that this book contains much of interest and of value to him. A chapter is devoted to practically every important topic which comes under the head of wireless telegraphy. Each topic is treated, first of all, historically; its theory is then taken up from a mathematical and physical standpoint. An experimental investigation is likewise included, as well as the discussion of the practical operation of the apparatus. The chapters on the induction coil are particularly interesting, one discussing it from the theoretical standpoint, and the other being devoted to the construction of coils from a ½-inch spark up to the largest sizes giving a spark especially adapted to wireless transmission.

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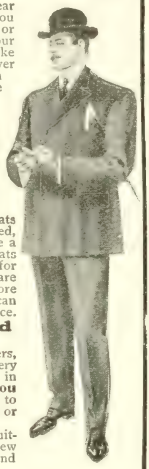

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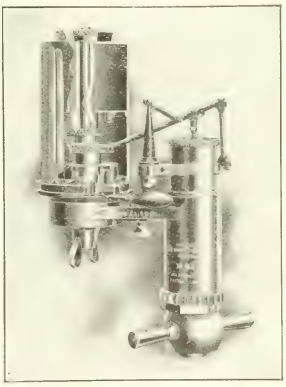

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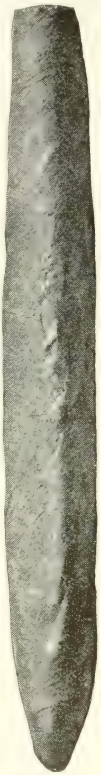

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Forge Practice. By John Lord Bacon. Instructor in Forge Work, Lewis Institute, Chicago. Cloth. Illustrated. 258 Pages, 7 1-4 by 5 inches. Published by John Wiley & Sons, New York. Price, $1.50.

THIS volume is compiled from the notes used by the author in teaching this subject to classes at the Lewis Institute; and it has, therefore, stood the test of actual use. It is not intended to take the place of shop experience, but rather to supplement it in order that the work may be done in the most intelligent manner. Forging is essentially a practical subject, and requires manual skill to a high degree; but the progress of the worker will be much more rapid if this skill be coupled with an intelligent understanding of the underlying principles on which the processes of forging depend.

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Under the subject of "Welding" are taken up the common types of welds, and the best method of making them is discussed. Another feature of the book is its treatment of "Calculation of Stock" for bent shapes, as well as for general forging. The chapter on "Tool Steel Work" is perhaps especially interesting and discusses the processes of hardening, tempering, different hardening baths, spring temper, annealing, etc. Numerous tables which should be useful to the blacksmith, may be found at the end. The book is profusely illustrated and well indexed.

The Polariscope in the Chemical Laboratory. By Geo. Wm. Rolfe, A. M., Instructor in Sugar Analysis, Massachusetts Institute of Technology. Cloth. Pages 320, 5 by 7 1-2 inches, Illustrated. Published by the Macmillan Co., New York City. Price $1.90.

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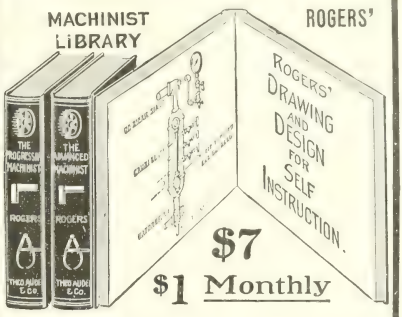

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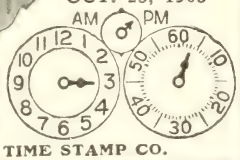

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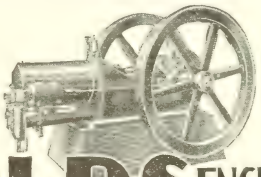

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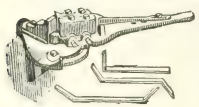

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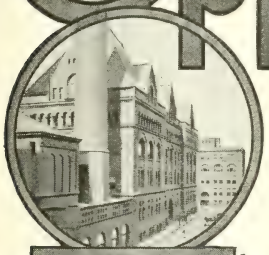

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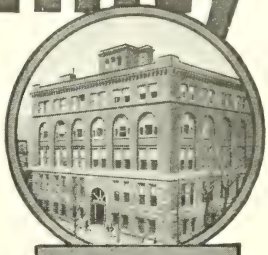

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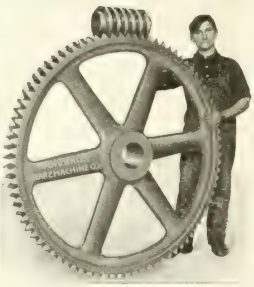

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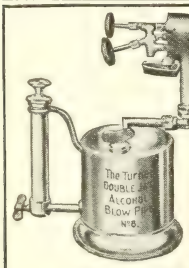

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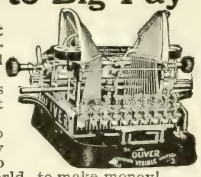

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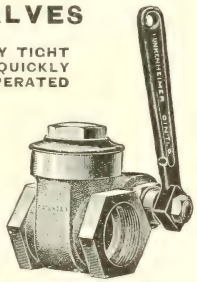

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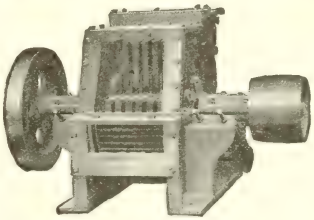

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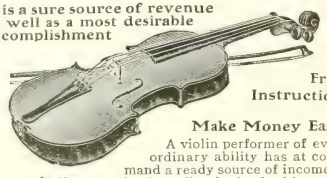

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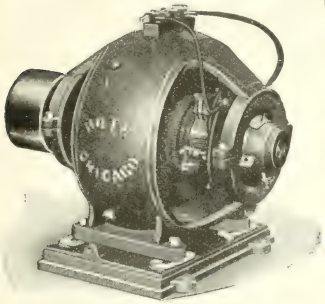

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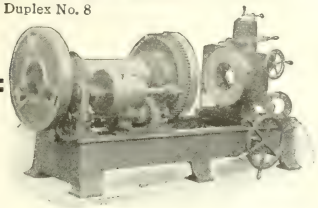

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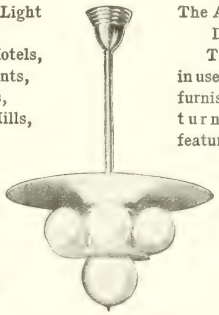

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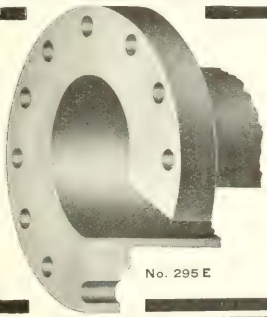

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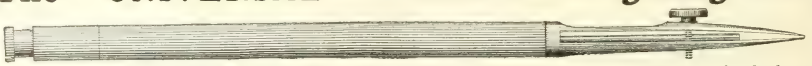

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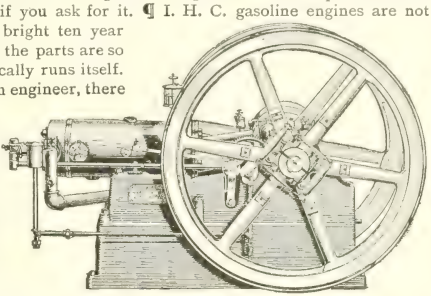

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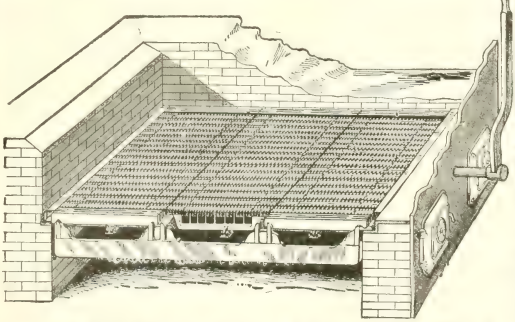

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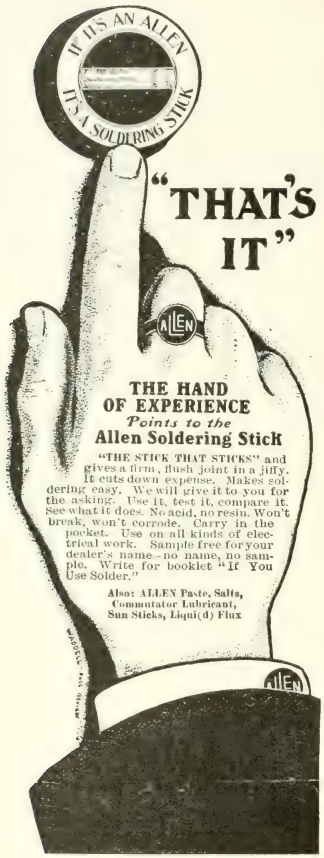

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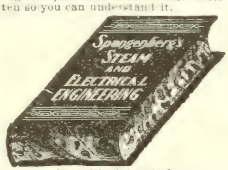

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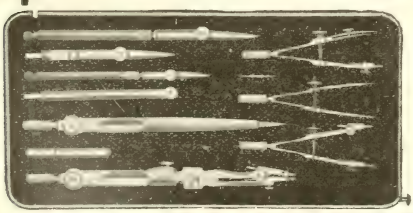

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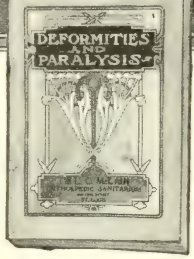

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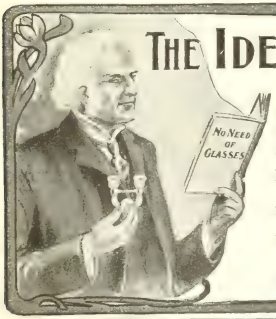

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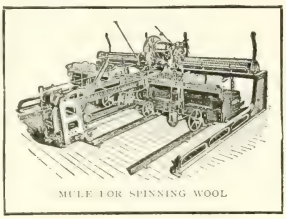

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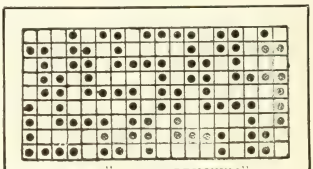

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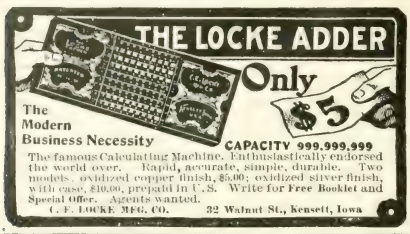

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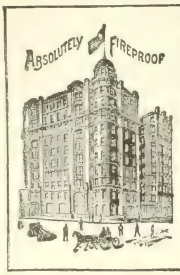

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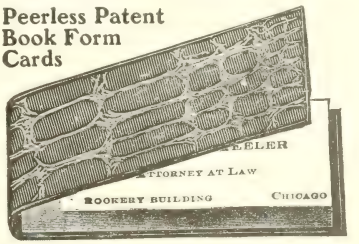

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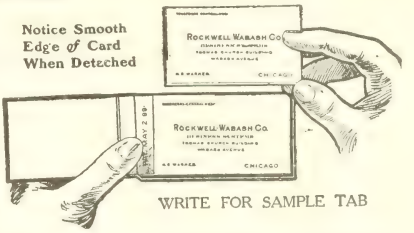

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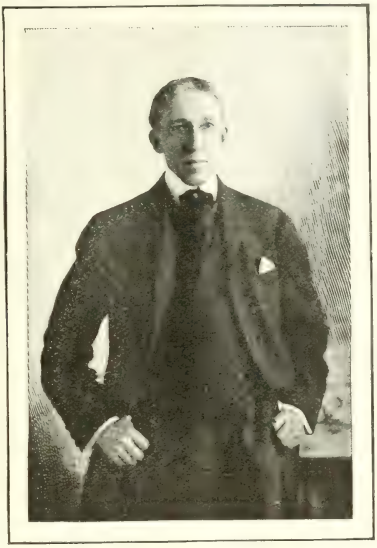

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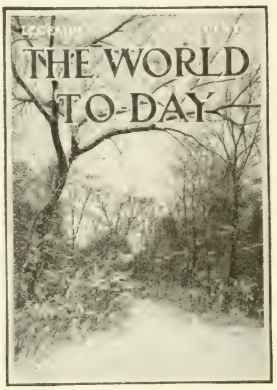

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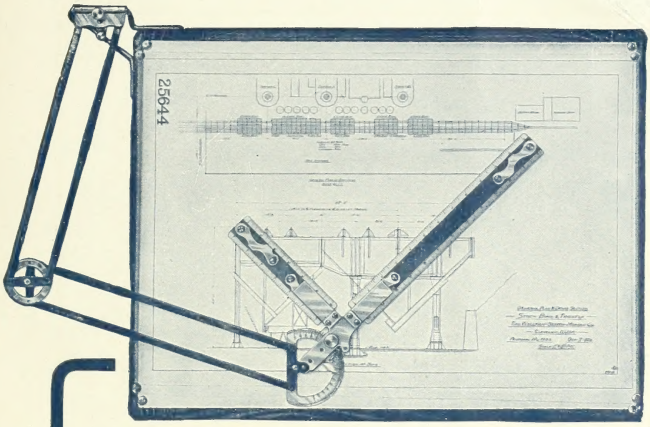

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